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ARE WE SOFT?

By L. E. CONRAD

Vice President, 1940–41

Having observed the many atrocities which have been committed in the name of education in the past forty years, I am forced to the conclusion that our educational processes must be mighty tough. How, otherwise, could they have survived?

The Mann Report of 1918, the Wickenden Report of 1929, the Jackson Report of 1939, and the Hammond Report of 1940, to say nothing of countless investigations and reports on Mathematics, English, History, Economics, et cetera, have come and possibly gone, but have produced little in the way of tangible changes. In view of the fact that most of the reports have declared engineering education to be in very fair shape, perhaps it is just as well that changes should be made rather cautiously.

The Mann Report, the first in the field, recognized the severe crowding in the engineering curriculum even at that time. In the past twenty years, advances in all fields of science and technology have added immensely to the material with which our graduates should be familiar. Of course, this same situation has existed in all other technical fields as well as in engineering. The professional groups working in most of the other fields have met the situation by extending the period of training required for entrance into the profession. The veterinarians, the lawyers, and the doctors may be cited as examples. Certainly, the reason for lengthening the training period is just as acute in the field of engineering as it was in the other fields.

In spite of this, it is suggested in some quarters that we should reduce the amount of time given to technical subjects in our engineering curriculums. It will be very difficult to do this. The writer ventures the opinion that, in general, *it will not be done.*

The answer—figure it out for yourself!

ENGINEERING TRAINING FOR NATIONAL DEFENSE

October 18, 1940

To Presidents of Institutions which offer Engineering Curricula:

Subject: Engineering Training for National Defense

You have already been informed of the passage of legislation providing $9,000,000 for intensive engineering courses of college grade, to be given by the engineering schools in fields essential to the national defense. This is to advise you of the policies and procedures that will operate in this program, and to invite the co-operation of your institution.

There is enclosed a list of "Questions and Answers" which it is hoped will help you in understanding how the training program will be organized and administered. If questions other than these arise, or if you have any criticisms of the plan as detailed in the questions and answers, you are requested to bring them to our attention at once so that the training program may be administered most effectively.

There is also enclosed a set of suggested outlines of the courses that will initially be offered. You should note that the courses cover both full-time "pre-employment" and part-time "in-service" training. The outlines are suggestive, and should be altered where necessary to meet local needs. Major changes in the "pre-employment" courses, however, should be avoided, since most of them have been designed to meet the requirements of the Civil Service Commission, where there is a considerable demand for men with the type of training set up in the suggested outlines.

It is not expected that all of the engineering colleges will offer the defense training at the outset, since many colleges may find that by virtue of location, remoteness from defense industries or lack of available facilities, it is inexpedient for them to participate. Institutions desiring to participate, that have special facilities for offering instruction essentially similar to the type required, should be prepared to supply for each course the information required in the preliminary proposal form. The enclosed mimeographed blanks are being sent out at this time in order to avoid the delay involved in clearing and printing the final forms. You may wish to use these as work sheets so that your institution will be ready to submit proposals very shortly after you receive the officially printed proposal forms. These will be sent to you in the near future.

In each region there will be appointed a regional adviser, who, under the direction of the U. S. Office of Education, will work closely with representatives of the engineering schools and with the defense industries in his locality. It is expected that the regional organization will be helpful to institutions in making future proposals. This regional organization should be completed shortly after November 1.

Cordially yours,

J. W. STUDEBAKER,
Commissioner

Engineering Defense Training

Preliminary Proposal

(This preliminary proposal is to be submitted in duplicate to the U. S. Office of Education by institutions which have special facilities for offering instruction essentially similar to that involved in the course outlined. Separate proposals must be submitted for each course for which an institution wishes to be considered. *"Answers to Questions" (EDT—Misc. 1), should be consulted in filling out this form.*)

1. Name of institution .....
2. Address ..... Date .....
3. Name of course proposed .....
4. Number of students institution proposes to train (*a*) Desired.....
   (*b*) Maximum.....
   (*c*) Minimum.....
5. How many days after authorization is received can you start instruction? .....
6. Indicate below the way in which the course will be given. (Check those that apply.)

   (*a*) *When:* Day ..... (*b*) *Where:* On campus.....
   Evening..... Off campus.....

   (*c*) *How:* Class Hours per Day..... No. Days per Week... No. of Weeks.... Total Class Hours.....
7. Attach to this proposal an *outline of the course* as you propose to offer it, giving (1) statement of objective, (2) prerequisites for admission, (3) a brief statement of subject matter and how it will be given, including the number of hours to be devoted to lectures and recitations, laboratory, and required preparation.
8. State on an attached sheet what industry or industries will be served by this course; indicate whether you believe the need is moderate, serious, or grave, and state, if possible, the approximate number you think should be trained. How was your appraisal made?
9. Who would be in educational charge of the course?

   Name ..... Position .....
10. Give on separate sheets the following information concerning the staff which would be used in offering the instruction:

    (*a*) *Present teaching staff*—(1) Name, (2) Rank, (3) Subject(s) to be taught, (4) Teaching Load in Hours per week for both regular and defense teaching, (5) Salary (Both for regular and defense teaching).

(*b*) *Additional Teaching Staff Required*—(1) Name, (2) Present connection, (3) Position, (4) Subject(s) to be taught, (5) Defense teaching load (hours per week), (6) Salary for defense teaching, (7) Summary of experience.

11. On separate sheets list the following equipment:[1]
    (*a*) Special equipment already available for the course.
    (*b*) Additional special equipment needed, including cost, for
        (1) Number institution would prefer to train.
        (2) Minimum number institution will train.
        (3) Maximum number institution will train.
12. Give on separate pages the information below concerning *additional* space requirements[1] if any:
    (*a*) Laboratory—Cost per square foot per week and total square feet needed for (1) number institution would prefer to train, (2) Minimum number, (3) Maximum number.
    (*b*) Class Room—Give same information as under 12 (*a*) above.
13. Are the housing facilities available for students considered adequate? .....
14. How do you propose to interest students in the course?
15. What aid can you give in placing those who have completed their training?
16. The following cost estimates will be considered as preliminary only, and may have to be revised after a course has been started. An accurate estimate of cost, based on actual enrollment in the course as of the end of the second week, will be given in the final "Plan" (EDT—Form 3). Particular attention is called to question number XXV in "Answers to Questions" (EDT—Misc. 1).

Answers to Questions Pertaining to Engineering Defense Training

Tentative

In the light of recommendations by the Advisory Committee on Engineering Training for Defense, the following answers are published by the United States Commissioner of Education as a guide to participating schools of engineering.

A. General

Question I: *What law authorizes the program?*

Answer: The sections of the First Supplemental Functions Appropriations Act, 1941, of particular concern to the engineering schools are:

[1] The law states that, "... not to exceed 20 per centum of the amount allotted to any school shall be allotted to it for expenditure for purchase or rental of additional equipment and leasing of additional space found by the Commissioner necessary for carrying out its approved plan. ..."

"Education and training of defense workers: For payment to States, subdivisions thereof, or other public authorities operating public educational facilities, and where hereinafter authorized to engineering schools and universities, through certification from time to time made by the United States Commissioner of Education (hereinafter referred to as the 'Commissioner') to the Secretary of the Treasury of the name of such agency or the name of such engineering school or university and the officer thereof to whom payment is to be made, and the amount to be paid, such payment to be made prior to audit and settlement by the General Accounting Office, for the furtherance of the education and training of defense workers as follows:

. . . . . .

"For the cost of short engineering courses of college grade, provided by engineering schools or by universities of which the engineering school is a part, pursuant to plans submitted by them and approved by the Commissioner, which plans shall be for courses designed to meet the shortage of engineers with specialized training in fields essential to the national defense, $9,000,000: *Provided,* That only engineering schools which operate under charters which exempt their educational property from taxation shall be eligible to receive these funds: *Provided further,* that not to exceed 20 per centum of the amount allotted to any school shall be allotted to it for expenditure for purchase or rental of additional equipment and leasing of additional space found by the Commissioner necessary for carrying out its approved plan."

. . . . . .

"No trainee under the foregoing appropriations shall be discriminated against because of sex, race, or color; and where separate schools are required by law for separate population groups, to the extent needed for trainees of each such group, equitable provision shall be made for facilities and training of like quality."

QUESTION II: *What is the objective of the program?*

ANSWER: As indicated in the law the objective is to provide courses "designed to meet the shortage of engineers with specialized training in fields essential to the national defense." It is not a general engineering program but training for a specific activity to speed up the preparation of the particular types of engineers urgently needed. The regular engineering curricula should not be disturbed.

QUESTION III: *Who is responsible for administering the act?*

ANSWER: The immediate responsibility for the administration of the act rests with the United States Commissioner of Education. He shall perform his functions under the direction and supervision of the Federal Security Administrator. The general regulations promulgated by the Commissioner shall be approved by the President in

order to assure the close integration of this program with other programs concerned with national defense.

QUESTION IV: *Who is responsible for determining the industries essential to national defense for which training will be authorized?*

ANSWER: The U. S. Commissioner of Education upon the advice and counsel of the Advisory Commission to the Council of National Defense.

B. Courses

QUESTION V: *What types of courses may be provided under the law?*

ANSWER: Intensive engineering courses of college grade.

QUESTION VI: *What is meant by "intensive" courses?*

ANSWER: Courses intended to train for a specific engineering activity of immediate application. The courses will ordinarily require 200 to 600 hours for class laboratory and preparation.

QUESTION VII: *What is meant by "courses of college grade"?*

ANSWER: The defense training program falls into two parts: courses of "less than college grade" administered by the U. S. Commissioner of Education through the State boards for vocational education; and "courses of college grade" administered by the U. S. Commissioner of Education directly through the schools of engineering. "College grade" here means work of an academic standard customarily demanded of engineering school students. It has no relation to the question of whether the school gives credit toward a degree for completing the course. Prerequisites will be stipulated in connection with course outlines approved by the Commissioner of Education.

QUESTION VIII: *Is the institution required to give college credit for the satisfactory completion of these courses?*

ANSWER: No. The matter of college credit is left entirely to the discretion of the institution.

QUESTION IX: *In what fields will the courses initially be given?*

ANSWER: The data available at this time indicate a need for courses designed to train engineers for service to Government and industry in the following fields:

Inspection of materials, chemicals and explosives, instruments and power units, especially ordnance and aircraft.

Design of machinery, equipment, tools and dies, and aircraft power plants, structures and instruments.

Production engineering and production supervision.

Physical metallurgy.

Marine engineering and naval architecture.

Other courses will be authorized as demonstrated needs arise.

QUESTION X: *How will the courses be organized?*

ANSWER: *A.* Courses primarily directed toward employment in new fields. These will generally be given as full-time courses, either on or off campus, and will involve at least 40 hours a week in class and preparation.

B. Courses primarily directed toward training those now employed for increased responsibility or improved technique.

These will generally be part-time evening courses, either on or off campus. They will involve about 15 hours a week in class and preparation.

QUESTION XI: *May the school of engineering modify suggested courses to meet specific needs?*

ANSWER: A certain degree of uniformity is desirable in order that those completing the courses may fit into available openings in Government and industry. On the other hand, the schools of engineering may modify the courses in order to meet specific needs.

QUESTION XII: *How will training needs be determined?*

ANSWER: Government needs will be evaluated by the U. S. Office of Education. Needs of defense industries will be determined by a regional organization of which the engineering schools will be a part.

C. Students

QUESTION XIII: *What means will be used to acquaint prospective students with the availability of these courses?*

ANSWER: Wide-spread announcements will be made through newspapers, technical publications, employment service lists, and by radio. In addition, each institution desiring to participate in the program is expected to inform its former students who may be interested, and to use such other means as may seem feasible to bring the prospective courses to the attention of qualified persons.

QUESTION XIV: *How does a person apply for admission to a course?*

ANSWER: Application is made directly to the institution of his choice. If for any reason a person is in doubt as to where the most satisfactory course for him is available, he should address the Engineering Defense Training Division, United States Office of Education, Washington, D. C.

QUESTION XV: *Who is responsible for the final selection of those admitted to the courses?*

ANSWER: The institution, subject to general standards specified for each course as approved by the U. S. Commissioner of Education.

QUESTION XVI: *How many will be trained?*

ANSWER: The number of students to be admitted to each course for the country as a whole will be determined as accurately as possible on the

evidence of demand for those trained for employment in defense industries and Government. A direct relationship must exist between the courses offered and reported needs.

QUESTION XVII: *Are there age limits for those enrolled?*

ANSWER: No.

QUESTION XVIII: *Can any provisions be made to cover subsistence?*

ANSWER: Not from these Federal funds. However, agencies such as the N.Y.A., W.P.A., and C.C.C. are organized to aid persons in need of financial assistance.

QUESTION XIX: *Will active duty for students under the Selective Service Act be deferred?*

ANSWER: This is a question to be answered by each local draft board.

QUESTION XX: *What aid will be given in placement?*

ANSWER: No jobs can be guaranteed. Students completing courses designed for Government service will qualify for civil service examinations. Others will be actively assisted in their placement efforts by the engineering schools. Finally, the public employment services are prepared to co-operate.

D. Engineering Schools

QUESTION XXI: *What engineering schools are eligible to participate?*

ANSWER: The law limits the "engineering schools" to those whose educational property is exempt from taxation. "Engineering schools" are interpreted to mean those offering regular engineering curricula, four years or longer, leading to a degree.

QUESTION XXII: *On what bases will a decision rest as to which engineering schools will be authorized to offer courses under the program?*

ANSWER: Only institutions which already have available the necessary equipment and nucleus of staff for offering these courses with the least additional outlay of money and with greatest assurance of sound instruction will be expected to participate.

QUESTION XXIII: *With whom does the U. S. Commissioner of Education deal in administering the program?*

ANSWER: The negotiations concerning the courses will be carried on with the head of the institution or with his designated representative. Final agreements shall be signed by the officer(s) authorized by law to sign contracts for the institution.

QUESTION XXIV: *Who is responsible for appointing new personnel needed?*

ANSWER: Those responsible for appointing regular personnel.

QUESTION XXV: *How may a school of engineering or a university of which a school of engineering is a part be certified for a grant of Federal funds?*

ANSWER: A preliminary proposal will be submitted in duplicate to the U. S. Commissioner of Education on forms furnished for that purpose. One copy of this proposal, when approved by the Commissioner, will be returned to the school. This copy is the authorization for the school to complete its plans and begin instruction, *provided* the enrollment exceeds the minimum and is less than the maximum authorized by the Commissioner.

Two weeks after instruction has been started, a final "plan" (forms to be supplied by the Commissioner when the approved preliminary proposal is returned) must be submitted by the institution in duplicate. This final estimate of cost will be based on the actual enrollment in the course as of the end of the second week.

This "plan," when approved by the Commissioner, will serve as a basis for certification to the U. S. Treasury for immediate payment to the institution of the total cost involved. At the conclusion of the course, any unexpended balance will revert to the U. S. Treasury to be credited to the Engineering Defense Training Fund.

If the final "plan" submitted by the institution involves costs substantially out of line with the preliminary proposal, the Commissioner will appraise the situation in consultation with the institution.

Should the enrollment in the course prove to be less than the minimum, the institution will not be authorized to offer the course. In this event, the institution will be reimbursed for organization expenses up to the amount authorized in the approved preliminary proposal.

QUESTION XXVI: *What is meant by "the cost" of a course?*

ANSWER: By "the cost" is meant the cost that the institution sustains in providing the course over and above the expenditures involved in maintaining the rest of the institution's program. This cost may include such items as:

1. Salaries and wages.
2. Actual and necessary travel expenses involved in carrying out the approved plan.
3. Instructional materials and supplies which are expected to be used up in the course, including reference books.
4. Maintenance and repair of equipment necessitated by the defense training courses.
5. Heat, light and power in so far as they are used in excess of amounts required in the rest of the institution's program.
6. A maximum of 20 per centum of the allotment to an institution may be used for "the purchase or rental of equipment or the leasing of space for carrying out its approved plan." Title to equipment purchased with Government funds rests with the institution.

However, if this equipment is not in use for defense training, it may be requisitioned by the Government during the period of the emergency for use elsewhere. Note that buildings may not be purchased nor built with funds from this appropriation. Leased space must be off college or university property.

7. Expenses necessary to the organization of a course.

QUESTION XXVII: *Will the Federal Government pay the full cost of all courses approved in the program?*

ANSWER: Yes.

QUESTION XXVIII: *After funds are received by the institution, what procedures are to be followed in making expenditures?*

ANSWER: Items authorized in the approved plan may be purchased under the same rules and regulations which the school of engineering follows in purchasing items with its own funds.

QUESTION XXIX: *What are the requirements for keeping and for auditing the accounts?*

ANSWER: The Federal funds allotted to an institution must be kept in a separate fund. All bills must be paid by check and receipted bills retained, except that items for personal services will be covered by approved pay rolls instead of receipted bills. A regular audit will be made by the institution at the conclusion of each fiscal year (June 30) and submitted to the Commissioner of Education. Auditors of the Federal Government may inspect these accounts at any time.

QUESTION XXX: *Who is responsible for the loss or misappropriation of Federal funds?*

ANSWER: The institution must make good losses or misappropriation of funds.

QUESTION XXXI: *If interest accrues on the fund while in the possession of the institution, to whom does the interest belong?*

ANSWER: According to a Federal ruling covering all Federal funds, any interest accruing upon Federal funds is the property of the United States and must be deposited with the Treasurer of the United States at the close of each fiscal year. A blank for this purpose will be submitted to each institution at the appropriate time.

QUESTION XXXII: *What reports of the work will be required?*

ANSWER: Periodic reports, both financial and educational, will be required on forms to be supplied by the Commissioner of Education.

THE ELECTRICAL ENGINEERING CURRICULUM FROM AN INDUSTRIAL VIEWPOINT*

By J. H. BELKNAP

Manager, Technical Employment and Training, Westinghouse E. & M. Co.

This paper is based upon the observations of one who for many years has followed engineering and who only lately has again become associated with curricula matters. The views are possibly those of the person who is looking into a changed world after a sojourn elsewhere. I am very much interested in the present state of affairs as contrasted with my last intimate contact with college work, as assistant professor of electrical engineering in 1923. I find the overall plan much the same as in the earlier years but note a number of changes which in my opinion are for the better. My interests in these matters are very definite, since I now deal with the product of the colleges and have the opportunity to observe with real satisfaction the progress made by recent graduates who are being assimilated by the Westinghouse Company.

The engineering graduate of today is well prepared to enter his life's work. I may say that we of industry, as represented by Westinghouse at least, are very well impressed with the young men who from year to year come to us requesting placement in technical positions. Their fundamental knowledge of electrical equipment is good. Their attitudes are fine and their ability to design, manage or sell can be quickly developed. Their years in college have seemingly provided a proper foundation for entrance into industry. But I am just a little concerned about one aspect of the training received at college, and it will be my attempt later in this paper to develop the thought and suggest a means whereby the colleges and industry may step closer together in the training of the young men of our country. I refer to the problems of guidance and orientation.

Most of you have read reports of the Conference on Engineering Curricula held in December, 1938, at Durham, New Hampshire. In that meeting, it was the consensus, if my memory serves me rightly, that the basic preparatory courses should continue to be emphasized for all engineering curricula; that the physical sciences and mathematics courses should continue to be considered as im-

* Presented at the 48th Annual Meeting, S. P. E. E. (Electrical Engineering), University of California, June 24–28, 1940.

portant components of all engineering and that these fundamentals should not, to any great degree at least, give way to a demand for popular and more spectacular courses. I believe that the industries, with the possible exception of those requiring specialized training, are quite in accord with the pronouncements made at that meeting. We of industry recognize that the engineering ability of our personnel depends fundamentally upon mathematical training, the knowledge of basic engineering principles and their interpretation in both design and application problems. We also recognize that the sale of proper electrical equipment requires at least a working knowledge of these same principles.

In discussing these matters with a group of our younger managers of design engineering departments recently, I found complete agreement as to the importance of basic preparation. All are agreed that the mathematical and physical science content of the electrical engineering curriculum, both in quality and quantity, is of the greatest importance. This group also emphasizes the benefit to be derived from the theory courses in electrical engineering which are, in reality, extensions of fundamental physics.

Of possible interest to this conference group, and a point which is not often admitted at such a meeting, is that these same key men in design have stated without hesitation that while higher mathematics is a most necessary and important part of the engineer's training, the use of the advanced mathematical tool in the conventional sense is not often a large part of the design engineer's day-to-day activity. There are within most of the designing departments stronger theoretical men who have specialized in mathematics and who have retained their special ability by constant review. Upon the shoulders of these few fall the larger part of the work requiring advanced mathematical support. Others in these same departments continue to use their mathematical training and their knowledge of engineering fundamentals, but do not, in large measure, actually resort to the processes of differentiation and integration as they proceed with their designing activities.

However, certain other engineering work, common to our industry, does require very definite use of advanced mathematics. I refer to such as central station engineering, in which the development of procedures, in connection with generation, transmission and distribution of energy to insure continuity of electrical service, is such an important application or consulting problem. Here, too, another advanced subject, symmetrical components, has a large application. The central station activity and certain other specialized fields require engineering talent with the very best advanced mathematical background.

We of industry have noted with interest the comparatively recent change in the amount of shop practice offered by the colleges. Carnegie Institute of Technology, for example, began as an institution for vocational training. Today this same school is outstanding in preparing those who are to assume the most important technical work. Shop practice courses have become a very minor part of the curriculum at Carnegie, and so it is for a great many institutions in other parts of the country.

There is some concern about this change, but we feel that the substitutions which have been made to provide more time for certain technical courses have been of positive benefit to the men who are soon to assume positions in industry. We see, though, some advantage in the continuance of certain manual training activities, especially if there is no opportunity for these courses to be given elsewhere or if the equivalent practical experience is not obtainable. We do believe that there would be a real benefit to those who are to undertake design, application and even the commercial activities of such a company as ours if the students could be given at least a basic understanding of machine shop practices and foundry procedures through the presentation of a survey course in shop departments.

Those who are to serve as manufacturing engineers or engineers in liaison between the design departments and the shop should, indeed, have a well-rounded knowledge of the manufacturing processes as found in a typical shop. The young engineer, no matter how able he might be, would not make much of an impression upon the shop foreman or his workers if he were unable to translate efficiently and accurately the design requirements involving machining operations. He must be aware of the simplest and quickest way of handling the product through all manufacturing processes.

It might be suggested, for the benefit of those who have not had the equivalent instruction or the practice elsewhere, that the more important elements of shop training be compressed into a single year—or even less. The object of such an abridged course should be that of acquainting electrical engineering students with machine tools, their uses and limitations, the problems peculiar to the design and manufacture of patterns and characteristic operations in connection with the foundry.

Possibly, too, such a course of emphasis points could be made more applicable for electrical engineering students through giving some consideration to the choice of proper electrical drive and control equipment for machine tools and other motor-driven shop equipments. This point is appreciated when we think of the problem of specifying the electrical drive for an ordinary punch press.

We are favorably inclined toward the change which has brought about a larger study of economics. We see, too, the benefit of associating this subject with the matter of production costing, as it has to do with raw materials, the manufacturing processes and the finished product. The teaching of "Engineering Economics" as contrasted with the more general consideration of the subject might accomplish the desired closer association between principles and industrial activity.

Industry sees the need for a better command of the English language and for the ability to speak before both small and large groups. As the engineer assumes larger responsibilities, he is often called upon to discuss his projects in conferences and to join other groups in which his opinion is wanted. Conferences between engineering, sales and manufacturing groups are common and are of almost daily occurrence. If he is concerned with either engineering or sales, he may be called upon to present his story to municipal or federal government groups or other purchasing agencies before a sale may be consummated. In short, he serves his company better if he is a good speaker. While it is something of a truism that speakers are born and not made, some do not discover their ability to speak until they have had instruction and experience. Therefore, I know the industries are in complete agreement with the thought that any instruction in the colleges that will improve the speaking ability of the young engineers should be retained, or added if not already a part of the curriculum.

A number of our people feel the importance of applied and theoretical mechanics. It is granted that the subject is simply an extension of physics, and we are all quite well agreed that physics is the basis of all engineering. A better knowledge of theoretical and applied mechanics is appreciated by those who have to do with the matter of application, or consulting service, and a great many of the customer problems have to do with the connected mechanical load. These are problems of "the front line," and before the electrical apparatus is to be specified a thoroughgoing study of the mechanical aspects must be made. Thus the electrical engineer must be a mechanical engineer of sorts, and a fundamental background in mechanics is vital.

If I may comment briefly on my own experience, I felt some uncertainty when I first undertook consulting-application engineering. It was my thought that the problems as set forth by customer engineering staffs might be the kind which would require quick answers on the basis of long-standing experience. Actually I found that the common-sense application of the principles learned in physics and mechanics would meet the larger requirements.

In continuing this same thought, the larger use of applied and theoretical mechanics, I should like to develop for a moment the situation which was found in a large group of men, all recent engineering graduates, beginning a graduate level course in a study of the application of electrical equipment. Out of 114, only eight men were able—or willing—to state a method of attack for the problem of quick stopping when the WR^2 values of all moving parts of a specific machine and its driving motor, their rotational or linear velocities and the available stopping torque from a magnetic brake were known. May I add that these men had been selected carefully from the colleges of the country—your own institutions—and, in my opinion, represented a cross section of the best college talent that could be obtained. This incident was a matter of just two years ago.

We are not particularly impressed with the need for specialized design courses in college. Fundamentals of design and all of the associated subjects, mathematics, physics and mechanics, are most important. In our opinion, modern design procedures can best be taught by industry, as the methods followed by industry are based upon the fundamentals as taught in college, but improved and even short-cut procedures are common.

The remark in connection with design courses leads us logically into a consideration of graduate level courses such as can be given by industry. Westinghouse has had for a number of years a graduate program with the University of Pittsburgh and, during the last year, we have established similar programs with three engineering schools in the New York metropolitan area. They include the Polytechnic Institute of Brooklyn, New York University and Stevens Institute of Technology. We are favorably inclined toward the offering of graduate degrees through coöperative effort of the institutions and industry. Our experience has been entirely satisfactory. We can now offer to our more ambitious young men, and older men too, instruction in design procedures which will provide credit for advanced degrees when the courses are completed under all scholastic standards. A definite point in favor of such instruction, as compared to on-the-campus courses, is that the design and application problems of the day—at the office or shop—may become the basis for discussions of the evening. There could not, indeed, be a better way to acquaint those desiring graduate work with up-to-the-minute procedures.

Advanced mathematics, specialized courses in physics, cultural type courses and other offerings which have long been recognized as within the college field should continue within the graduate educational programs of the institutions. The subjects which are

closely related to design and application and which are the common activity of the industry should be taught by industrial lecturers. We commend this type of graduate program to the institutions and the industries which have contiguous locations.

And now may I come to the point to which I alluded in my brief introductory remarks.

My contacts since leaving actual engineering work have caused me to consider very actively the matter of the choice of positions. I have had to do, in my past three and one-half years, with the selection, training and placement of young engineers within our Company. I have observed that our graduate students who come from the colleges located in the industrial areas are fairly well oriented as to the requirements of industry and the various types of positions to be found there. The farther removed the college is from the industrial center, the less the graduates know of the actual work to be encountered as they begin their industrial experiences. This situation is not always confined to the industrial areas, as we have found, in certain instances, that students who have had their training in the New York metropolitan area had an entirely incorrect conception of not only the commercial, but also the design work. When these fields of endeavor are interpreted in plain language to student groups, we find that many of the individuals request consideration for other and totally different fields than first indicated as preferences on their application forms.

To give emphasis to this thought, I want you to hear what an editorial in the February 15, 1940, issue of *Sales Management* says:

> In the February 1 issue Sales Management reported the results of a survey made among seniors in 12 colleges and universities to determine the attitude of these men toward selling as a career. The returns were shocking. An alarmingly large number of those interviewed think of salesmanship not as a profession, not even as a business—but as an 'undesirable racket or as work for morons.' . . .
>
> Most economists agree that in finance, in engineering, and in production we are relatively far more efficient than in distribution, and it is distribution that needs refining and perfecting if we are to reduce corporate losses and create more jobs. What a paradox it is, then, that such a large proportion of the next generation of career men look upon salesmanship as a racket which holds no appeal for them, offers no challenge to their talents. What a paradox that salesmanship has neither seen the need for, nor been able to sell itself!

While salesmanship in some fields is not to be desired by the engineering college graduate, it is on a distinctly high plane when it is concerned with the sale of an engineering product. I am not proposing a course in salesmanship, but using the editorial quoted

to point out that the senior in electrical engineering should know the facts concerning commercial activities and their ultimate possibilities.

The subject of orientation has no doubt been discussed on many occasions by the membership of this Society. Others no doubt have the same thoughts as mine, and I will admit my own thinking has been brought about by a recent close-up view of the situation.

The selection of an employer after graduation is a momentous step for a young man, and the candidate for a position should have the very best counsel before launching out upon his life work. Too many individuals think only of research as their field, and they do so only because they do not have correct information as to other possibilities. Oftentimes designing is incorrectly pictured as sitting before or standing at the drafting board. To adjust to this need, I do not propose any change in curricula. The physical sciences, mathematics and other regular courses of study are too important and should not give way to more general instruction. Reviews of the offerings of industry, however, are important, but they could be handled as sideline or "extra-curricular" activities, if you please.

Conversations with faculty advisers provide ideal opportunities for guidance. If the faculty has not had industrial experience, the industries of his area might assist by providing summer contacts and possibly employment for those interested. The industries should also be broad-minded to the extent that industrial employment should be made available to those who desire eventually to follow teaching careers. In my opinion, college work can be more effectively done after a period of preliminary service in a chosen field in an industrial organization.

Coöperative courses are ideal for orientation if sufficient choice of industrial employment can be offered, and if there are a number of definite types of activity available to one who is so fortunate as to be enrolled in a coöperative plan. Our own experience in the George Westinghouse Scholarships in Carnegie Institute of Technology has shown that the best way to point out the various available activities is to give the scholar a chance to serve in several. In our first group of ten scholars, we found interest as follows: mechanical engineering—4, electrical engineering—3, industrial engineering—1, chemical engineering—1, and metallurgical engineering—1. All of the boys were put to work during their first summer in the field of indicated first interest. They were brought together for round-table discussions and informal reports on their activities and, as a result of this opportunity for exchange of information, two men from the mechanical engineering group have expressed a

desire to change their life activities and are now following industrial engineering. The second summer's experience has given each the preferred type of work, and it now looks as though all of the ten scholars will remain in the field chosen after the first experience —or confirmed by the first experience. We will, of course, stand by to counsel with all of the group—shortly to include fifty carefully chosen young men—and arrange for their final industrial experiences after definite attention has been given to preliminary assignments.

It would seem that for other than coöperative students orientation should begin in the senior year, if not as early as the junior year. Again I must say that I am not suggesting a change in curriculum to accomplish this, but rather propose that the student societies, the local chapters of the A. I. E. E. and A. S. M. E., should be used for such purposes. Possibly the faculties should devote occasional evenings to discussions of the various kinds of work and, in these discussions, devote time to an analysis of a typical actual day's work as found in the various fields. I am of the opinion that orientation conferences are often too general and do not supply the information needed. Industries should coöperate and supply speakers who are particularly qualified to describe the various opportunities or to trace the various steps in an order for manufacture, which order brings in all of the activities as found in that particular industry.

Orientation should carry on beyond the academic classroom. Here the industries should take up the responsibility under a definite plan and give the graduate student or test-course man the benefit of working in the various fields of activity until the right position is found. Segregation should be made on the basis of capabilities and interest, but not until the candidate has actually been tried out in the actual work which he is to follow. All of us will agree, I believe, that one can go further in serving his company and advancing himself if he is happy in his work.

In conclusion, if the thought spoken by Westinghouse may represent the cross section of opinion from industry, I may say that the well-balanced courses in electrical engineering as offered by the colleges of the United States provide a fine background for graduate training in design and other activities which are common within our operations. We look with favor upon coöperative work as an excellent means of orientation, and we commend coöperative graduate programs for the colleges and industries having contiguous locations. Our other suggestions for orientation allude to responsibilities which we of industry should feel toward the colleges, and it should be our effort to assist in this more or less extra-curricular

type of activity. It is reasonable to expect that industry will assist in providing the industrial background for those who are to teach the young men. As a comment on the product of the colleges, the attitude of the young men is exceptionally fine. We notice almost nothing of the radical thought which has been brought to our attention by the newspapers commenting on the student situation in certain of the European countries. By and large the graduate students who come from your institutions are ambitious to the point of electing almost too many courses for their further advancement.

Appendix I

Evolutionary Trends of Electrical Engineering Curricula

There have been many changes in the electrical engineering curricula within the past fifteen years. As may be noted from Chart No. 21, p. 123, "Present Status and Trend of Engineering Education in the United States," these changes have brought about a streamlining of the curricula and a shortening of the total hours required for a degree of approximately six per cent.

Chart No. 21 shows that the following changes have been completed. All foreign language requirements have been eliminated, with the exception of a very few schools. Courses in the social sciences have increased both in number and credit hours. Economics courses, too, have been extended. The basic fundamental courses, those in mathematics and the physical sciences, have remained nearly stationary. English and physical or military training requirements have seen little change. The total change in all these general academic subjects has shortened the required hours and provided time for an increase in elective courses, both free and technical.

In the list of subjects special to engineering, we find that the time spent in graphics, mechanics and shop courses has been considerably shortened. Courses specifically under the direction of the electrical engineering department have also been curtailed. These decreases have provided more time for electives and "other engineering" courses, but have also resulted in a shortening of the total time spent on technical subjects.

The changes in the graphics and shop courses have been accomplished by elimination of obsolete subjects, combination of courses and improved teaching methods. Condensation of subject matter into survey material has helped to shorten the time spent on mechanics and hydraulics in a number of schools. A trend to place more of the design courses and specialized subjects in the classifica-

tion of senior technical electives has transferred the credit previously given to specific electrical engineering courses from the required to an elective classification.

The increased need for the engineer of the future to have a general knowledge of many related technical phases of industry has led to the addition of subjects in the classification of "other engineering." A number of schools are now giving their electrical engineers survey courses in mechanical engineering for a general knowledge of central-station apparatus or a course in civil engineering for future help when planning transmission lines.

A further survey of the electrical engineering curricula in nine schools that are of particular interest to our Company, as taken from their latest catalogues, shows that previously apparent trends may have been checked and that the curricula are now going through a process of gradual improvement by betterment of individual courses. The schools in this survey include one from the New England states, two from the Middle Atlantic states, three from the Midwestern states, one from the Missouri valley, one from the Southwest and one from the South.

The following chart which tabulates the curricula from these schools shows a close approximation to the report mentioned above. Wide variance is found only in the classifications of electives and those of "other engineering." Notwithstanding differences of interpretation, we find that the trends mentioned in the accompanying paper entitled "The Electrical Engineering Curriculum from an Industrial Viewpoint" are apparent by a comparison of these two curricula surveys.

It is also noted that the average graduation requirements of the nine schools taken here is $146\frac{3}{10}$ hours as compared to the $144\frac{5}{10}$ hours required in the E. C. P. D. report. These graduation requirements vary from a minimum of 139 hours to a total of 154 hours for a regular four-year curricula. The columns headed by the letters A–I are the curricula breakdown for each of the nine schools. These curricula are then averaged and the column headed "Percentage" shows the portion of the average curricula devoted to each subject. The E. C. P. D. averages are then tabulated and the last column on the chart shows the variation between the two surveys.

It will be noted that the portion of the curricula devoted to free and technical electives has been greatly increased. This seems to be the one prevailing recent trend, that more of the technical subjects are allowed to be substituted for electives during the senior year.

A Comparison of Curricula in Electrical Engineering

A survey of the electrical engineering courses being given in nine representative schools compared with Chart No. 21, p. 123 published in "Present Status and Trends of Engineering Education in the United States" by the Engineers' Council for Professional Development.

	A	B	C	D	E	F	G	H	I	Average	%	E. C. P. D. Report		Variation
												Average	%	
Technical Subjects														
Electrical Engineering	41	42	35	35	28	41	36	43	38	37.7	25.8	36.5	25.3	+0.5
Other Engineering	16	8	11	11	9	8	10	19	8	10.0	6.9	16.2	11.2	−4.3
Mechanics—Hydraulics	14	10	12	14	18	12	11	6	10	11.9	8.2	10.4	7.2	+1.0
Graphics	13	4	6	8	9	8	10	8	4	7.8	5.3	5.5	3.8	+1.5
Shops	3	3	3	x	6	3	6	2	4	3.3	2.3	5.5	3.8	−1.5
Non-Technical Subjects														
Physical Sciences	20	24	16	24	20	18	18	16	20	19.6	13.4	19.3	13.4	±0.0
Mathematics	10	15	16	18	18	19	19	20	23	17.5	12.0	17.5	12.1	−0.1
Economics	5	6	11	6	3	x	3	3	8	5.0	3.5	5.5	3.8	−0.3
Social Sciences	2	x	x	x	x	x	3	3	12	2.2	1.5	2.7	1.8	−0.3
English	3	12	10	10	8	6	11	11	9	8.9	6.1	8.1	5.6	+0.5
Foreign Languages	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mil : Sc.—Phys. Educ.	x	8	10	4	4	7	4	4	6	5.2	3.6	5.5	3.8	−0.2
Electives—Technical and Free	22	15	22	14	24	19	9	19	5	16.6	11.4	11.8	8.2	+3.2
Total Hours	149	147	152	144	147	141	139	154	147	146.3		144.5		
											100%		100%	

REPORT ON THE INVESTIGATION OF THE TEACHING OF ENGLISH IN ENGINEERING SCHOOLS *

By H. S. ROGERS

President, Polytechnic Institute of Brooklyn

History and Procedure

Many influences are stimulating a constant restudy and re-evaluation of all phases of engineering education. There has been a noticeable growth of a professional consciousness in recent years as is evidenced by the adoption of state licensure, the progressive maturity in the activity of national professional societies, and the study of all phases of engineering training under the aegis of the E. C. P. D. Therefore the decision of the English Conference at the Annual Convention of the Society in June, 1936, to recommend that instruction in English in engineering schools be investigated was a normal expression of current interest. Complying with the recommendation,† the officers of the Society appointed a Committee in 1937 to begin the investigation and secured a generous grant for the study from the Carnegie Foundation for the Advancement of Teaching.

Since 1937 the English Committee has attempted to study the aims, methods, and results of instruction in English and to describe and define the functions and problems of English teachers and departments, and furthermore to explain the relationship of English instruction to the purposes of engineering education to the end that better immediate mastery of the arts of expression might be secured and that earlier and greater progress in the cultural development of engineering students and junior engineers might be stimulated. These general objectives have been approached by an examination of the plans and methods now in use, and certain recommendations have been made that, it is hoped, will encour-

* Presented at the 48th Annual Meeting, S. P. E. E., University of California, June 24–28, 1940.

† The Society for the Promotion of Engineering has often called attention to the importance of English. In the report of the Board of Investigation and Coördination, June, 1929, there is a statement emphasizing the importance of good English. As recently as March, 1940, the Committee on Aims and Scope of Engineering thought it desirable to say that the Society for the Promotion of Engineering Education should encourage the "ability to organize thoughts logically and to express them convincingly in oral and written English." In addition, the Committee suggested that engineers should have an "acquaintance with some of the great masterpieces of literature and an understanding of their setting in and influence upon civilization."

age better programs, inspire more vital interest, and bring about more coöperation between teachers of English and teachers of engineering subjects.

The Committee has collected many facts and opinions through questionnaires addressed to Presidents, Deans, and Heads of English departments of all the engineering schools, and also selected instructors and selected engineering graduates. The replies to these questionnaires, together with data taken from other studies, have been used as the basis for seven reports published in the JOURNAL upon the teaching of composition, literature, speech, the selection and training of teachers, the organization of departments of English and conditions surrounding their work, and unique methods employed in English instruction. The conclusions and recommendations have been published in the eighth and final chapter, and they will be reviewed briefly for the Convention.

TRENDS IN THE TEACHING OF ENGLISH

At present there is an increasing emphasis upon the need for more adequate training in composition and speech and a growing interest in the study of literature. The new emphasis on composition and speech is a reappraisal of their significance and value rather than a pressure for increased requirements. It is felt that better results should be obtained by an improvement in the quality of instruction and by a change in the attitude throughout the engineering schools toward the writing and speech habits of all students. It is thought that the objectives of the courses should be conceived in terms of the development of the student in arts, skills, abilities and powers, in interest and appreciation, in attitudes and points of view.

The programs presented and the plans followed vary considerably in the widely different circumstances found in the independent engineering schools, in the state colleges, and in the state university systems. The average number of credit hours devoted to English in the engineer's training is 13.48 quarter hours or approximately nine semester hours. These are distributed as follows:

Elementary composition	7.40 quarter-hours
Advanced composition	0.59
Technical writing	1.40
Business English	0.11
Journalism	0.03
Total in composition	9.53 quarter-hours
Public speaking	1.20
Literature	2.75
Total in English	13.48 quarter-hours

The greater proportion of time is devoted to instruction in the elements and in the special applications of composition. This work is usually scheduled for three credit hours in each of the semester or quarters of the freshman year. The remaining portion of the time is devoted to public speaking and literature and is approximately four and one-half quarter-hour or three semester hour credits.

Composition

Two approaches to the development of facility in composition—or perhaps it would be more correct to say—two different emphases in the instruction in composition are found. One is upon mechanical skill, and the other upon thought processes. These are the horns of the old dilemma involving the requirements of "having to say something" and "having something to say." The procedure more frequently followed is designed to integrate the two. It is thought that the objectives of the work in English are, nevertheless, too often limited to syntax and routine drill, and that the effectiveness of the work might be improved by a distribution in the schedule which would provide some training in composition in the upper division of the curriculum.

One of the difficult problems encountered in the teaching of composition is created by the different abilities of the freshmen students. Some are so deplorably ignorant in English that they must spend much time in elementary drill. Others are better qualified and are prepared to take up the organization of thought and the systematic work in composition. This condition is met in some instances by the requirement of drill courses without college credit and in others by sectioning according to ability. So far, no one has been able to devise a satisfactory way to deal with the unprepared student.

It is agreed that the individual conference, when effectively conducted, is the most constructive and often the most important part of the instruction in composition. The schedules and the teaching loads of English instructors should, therefore, be arranged so that these conferences may be effective.

Public Speaking

There is probably more general enthusiasm for speech training than for any other work given in the English department. It is generally agreed that instruction in speech is equally important with any other type of instruction in English. There is general approval of the present aims and practices of courses and of the effectiveness of the teachers of speech. Most administrators en-

thusiastically approve training in speech and a number advocate giving more attention to it. Students, graduates, and instructors generally agree that the course in speech should be three or four semester hours in length. The larger number of students questioned favored giving the course in the sophomore year. Criticism was expressed of those courses combining speech with composition under the direction of instructors whose training is limited to one or the other of the two fields.

Literature

Though instruction in literature is not so generally approved as instruction in composition and speech, a majority of representative engineering educators, practicing engineers, personnel men, and recent graduates favor the teaching of literature in engineering schools. While composition and speech are considered primarily as tool courses, literature is thought to be desirable as a background for human understanding and for helping to develop a philosophical attitude toward life. The term literature as used here includes many types of writing, such as poetry, drama, essays, orations, biography, and the novel. Both the classics and modern books are included in the courses in engineering schools. Though the programs in various institutions vary, it is thought that literature should be taught for its human and aesthetic values rather than as a critical study of styles and periods.

The consensus seems to be that courses in literature should encourage students to read widely with understanding, appreciation, and enjoyment; should stimulate an appreciation of the aesthetic and philosophical approaches to life; should establish good reading habits that may become lifelong; and should result in the attainment of cultivated standards of taste, of tolerant human attitudes and of philosophical points of view. One engineer very appropriately remarked: "The study of literature should help engineering students become educated men rather than trained technicians."

Organization and Administration

English departments in schools of technology, in colleges, and in universities are organized in a variety of ways. In some technical institutions they enjoy a status comparable to the major engineering departments. In colleges and universities they are most frequently units of the arts college. Sometimes they are officially affiliated with the engineering faculty, and sometimes they are housed in the engineering buildings. Instructors responsible to the arts college may teach students from the different colleges or

be solely responsible for the teaching of engineers. In most instances the engineering students are segregated in separate sections.

It is agreed, however, that the plan of organization is not in itself essential to satisfactory results in the teaching of English. More important than formal organization is the recognition by all engineering instructors of the purpose and value of work in English and the complete support of the administration. Constructive attitudes and results are dependent in large part, however, upon the creative leadership of English instructors, their appreciation of the problems involved in catching the interest of engineering students, and an understanding of the technique for effective instruction.

Conditions surrounding the administration of many English departments could be improved. Teaching loads should if possible be reduced to twelve clock hours in the class-room and the supervision of not more than eighty students. The ranks and salaries of instructors in English should be commensurate with those of engineering instructors. There should be more teachers of the higher rank assigned to the instruction of freshmen. The work of instructors in English should be made more attractive by according it recognition as an integral and indispensable part of the engineering curriculum. Under conditions in which the English department of the liberal arts college is responsible for the instruction of engineers, there is too often a tendency to regard this work as mere routine and as something apart from the professional interests and aspirations of the staff. The condition could be improved if the English department were regarded as an allied department teaching basic courses rather than as a service department directing freshman routine.

There is no inherent reason why English instructors should not find a challenge in the education of youth as well as in the pursuit of special scholarly interests. The mastery of some field of human letters and a competency in the instruction of lower division students are not incompatible. The stimulation and the recognition of inspired and creative instruction would do much to alleviate existing conditions. This is a challenge to the leadership of both the engineering and the arts colleges.

There is a great deal of confusion about the kind of teacher wanted in the English department of the engineering school. Persons with all sorts of training have been successful in teaching engineering students. General intelligence, alertness, sympathy, understanding, courtesy, refinement, industry, and perseverance are, of course, essential traits for all teachers; but the scholarship, the general cultivation and the attitude of instructors who aspire

to success in teaching English to engineering students should be characterized by particular qualities. The instructor should not only have a mastery of a particular field, but he should also possess the amateur's enthusiasm for all cultural pursuits. Furthermore he should have a breadth of interest that will enable him to get excited about the world in which we live.

It is not essential for the English instructor to have a critical knowledge of science or a technical understanding of its applications. It is, however, imperative that he have no disdain for men who have contributed largely to our civilization by their achievements in science and in engineering. It is just as possible for the English instructor to be a snob as it is for the engineer to be a bore. The English teacher who succeeds in teaching engineers will undoubtedly appreciate the relationship between the arts, the humanities, the social sciences, and the biological and physical sciences.

Instructors should have training in how to teach composition. At present most students who win advanced degrees in literature have little preparation for teaching composition; yet most of the young Ph.D.'s have to teach composition a long time before they are allowed to take charge of specialized literature courses. It would be helpful for instructors who expect to teach in engineering schools if they had some training in how to present composition to freshmen.

Those who possess the necessary qualifications can be prepared for unusual success by the coöperative study and consideration of the objectives and teaching methods pursued within the English department itself. Recognizing that teaching is an art it may, nevertheless, be helpful to give some study to educational psychology and to special teaching methods. The serious study of the objectives and methods of work within the English department and the frank discussion and criticism of a group of teachers working toward recognized and understood goals will do much to raise the general quality of instruction and improve the results obtained.

It must always be recognized that it is just as difficult to recruit and develop a strong staff for instruction in English as it is to recruit and develop a strong engineering department. It must also be admitted that best results can be secured only where teachers are conditioned under vital departmental leadership. It is furthermore certain that if recognition and promotion are not forthcoming a staff cannot be maintained at a high level of competency.

The English Committee is giving serious study to a plan for the development of young instructors who have the required in-

terests and abilities for large success in teaching engineering students. The proposed plan would provide subventions for properly qualified men who are now teaching engineering students. It is hoped that it may be put into operation at an institution where they may serve an active apprenticeship in teaching technical students under competent direction and where they may have the opportunity for broadening their own culture by a study of subjects of interest to them. Such studies would be pursued with no thought of academic credit.

In conclusion, it should be stated that if engineering is to hold a place among the learned professions its personnel must be educated men of broad culture as well as capable engineers. Hence the instructor and the department that creates an awareness of good usage, orderly thinking, and stimulates students to continual and conscientious study, both in school and in later years, that encourages students to inform themselves about modern thought and ideas, and imparts an inspiration for the aesthetic and philosophical approaches to life will render a great service. The engineering instructors who have the wisdom to recognize such work and the breadth of vision to coöperate with the teachers of the humanities will graduate engineers who will rise to high levels of achievement and responsibility and take their place beside the members of the other learned professions.

THE TEACHING OF LABOR RELATIONS*

By F. ALEXANDER MAGOUN

Massachusetts Institute of Technology

No man can be a good teacher without a genuine desire to bring together his two loves—the students and his subject—in such a way that the first will have an understanding and abiding appreciation of the other. It is not enough that he be intimate with the Goddess of Wisdom. He must know how to present her in such a way that the boys will also want to become life-long devotees.

Neither teaching, nor management, nor labor organizations are ENDS in themselves. They are merely MEANS to a common end: namely an increase in human happiness. Thus basically they all have a common goal.

Any course in labor relations that is to be more than an uninspired and trudging parroting of dates, legislation, payment plans and industrial struggles, must be developed from a consideration of the fundamentals of human behavior. We have too often made the mistake of dealing with temporary superficialities instead of long run fundamentals. This, because it is: (1) always difficult to be really fundamental (particularly true in new fields); (2) easy to get interested in some growing edge.

As a result, we find ourselves teaching the Wagner Labor Relations Law as though it were a necessary fundamental, instead of using it merely as the passing illustration it actually is.

WHAT ARE THE FUNDAMENTALS?

I. Always to think *structurally* and with *good method.*

(*A*) Unless you have a skeleton first, the result can be only a jelly fish.

(*B*) When there is structure can you see: (1) true proportions; (2) missing parts; (3) proper places for future additions?

II. Constant emphasis on the limitations of a scientific approach in a social field.

(*A*) Usually we cannot isolate variables and control experimental conditions.

(*B*) We cannot be impersonal or objective in observation and in deduction.

* Presented at the 48th Annual Meeting, S. P. E. E. (Labor Relations), University of California, June 24–28, 1940.

(*C*) We cannot use present observations to predict the future because new factors are continually changing conditions. Our present premises are not basic law, but only partial expressions of truths we do not yet fully understand. There are still discoveries to be made in the social sciences (as basic as the law of gravity) of which we are completely ignorant.

(*D*) Our ignorance of these basic truths leaves us with only a surface complexity of factors so baffling we cannot yet see the relation of cause and effect. If a beam fails we know how to make it stronger. If a union goes out on strike, the remedy that will avoid recurrence is not positively indicated. Perhaps the weavers strike for higher wages, but the real trouble may be bad lighting of the looms. The natural scientist weighs, times, measures. Can we measure the excellence of a foreman by the weight of his head, or by observation of the time he leaves home in the morning? Some day we shall have reliable mensuration.

(*E*) The number of possible experiments is limited. The natural scientist can make hundreds of small experiments in a test tube. Experiments with a few workmen are unreliable. It has to be full scale, and that is both dangerous and expensive.

(*F*) Time means nothing to the researcher in natural science, but in industrial relations one cannot wait for the answer till all the facts are in. Men would starve and mills would go bankrupt.

III. To be fundamental the teacher must make the student see his own times and problems as a dynamic part of the past and the future. He will easily be led to see how past expediency has brought about present trouble. He must also be made to see how difficult it is for us to recognize our own mistakes, or to realize that our own convictions will seem unsupportable to a newer generation.

Labor organizations are here because past management was prejudiced, ignorant, and greedy. The artizan trusted his boss in the beginning because in the small shops of the early 1800's the boss usually was trustworthy. Factories grew. Management forgot that men were not machines; the important difference for this discussion being that one has emotions and the other does not. Workmen first became confused, then suspicious, then organized in open rebellion. Management resorted to expediency. Expediency is a sure-fire symptom of poor thinking and poor planning, which is why it usually leads to trouble. Unions arose in self-protection and because of the frustration of more reasonable methods. (Everybody needs to be treated so that he has a feeling of security and appreciation. After ten years of work the Yale Institute of Human Relations is *sure* of only one thing: aggression is caused by frustration.)

After the damage was done and capital had fought labor in a series of battles which, as always, impaired the object fought for, management has now begun to realize what it should have seen in the first place: continuing good profits are possible only when one manufactures good goods; good goods must be made by good men and good men are developed only by good labor relations.

The treasurer looks out for the interests of capital; the sales manages keeps goods moving by constant attention to the needs of the customer. It is equally important to have an intelligent, properly staffed industrial relations department to develop good men and to keep them coöperative by *sincere* coöperation with them.

In the past we did not realize that it is a great mistake to think one can coöperate intelligently without training. Correct education here (I did not say schooling) is just as necessary as in learning to become a good loom fixer. There are many technical problems in good coöperation. Without proper preparation one will mess up industrial relations just as inevitably as he will spoil the adjustment of a loom.

On the second day of a strike a respected friend of mine who was personnel man for a chain of southern cotton mills offered his weavers a company truck so they could go fishing. Weeks later, when the Union, beaten completely, wanted him to sign a contract entirely favorable to the mill, he said, "No. That isn't fair to the workmen, and I won't sign anything that isn't fair to them." To do a thing like that, a man must have long run policies, understand them, and believe in them. Fairness is always the basis of good relations. But what is fair both now and in the future? That's where part of the education comes in.

IV. To be fundamental, a course in labor relations must succeed in getting into the habit patterns of the students the technique of always approaching any problem with a determined attitude to see it and to *understand* it from both sides. This is particularly necessary—and difficult—when the people on the other side are different from ourselves. Only by supreme effort of the will can we overcome a bias (persistence of an old pattern of thinking when it no longer applies). It is almost impossible to overcome a prejudice (wanting to persist in a pattern of thinking for purely emotional reasons).

In human relations nothing is any good until it has got down to the level of feeling. This cannot be reached by lecturing to the class. For effective results the class must be put into situations where it can actually see and feel the difference a bilateral approach makes. To do this Elliott Smith of Yale devised the Case Demonstration concerning which this society has heard previously.* Dur-

* Magoun, F. A.: "Training Engineers in the Art of Human Relations," JOURNAL OF ENGINEERING EDUCATION, Oct. 1937, pages 142–150.

ing the past year I have introduced a refinement in my own use of this pedagogical device. Previously two men from the class were selected to act as the management in handling a case when the Union representative came to the class on the day of the demonstration. This year there have been two changes.

(1) Appointment of an additional two students to play the opposition and act as Union representatives in helping their managerial classmates prepare for the demonstration. This is exactly like the Varsity practicing on the second team until the day of the game.

(2) At the exercise following the demonstration, reading to the class a stenographic record of exactly what was said at the actual conference in the company where the real case originated. It is entirely wrong to use companies where management and labor quarreled. This makes the student see the two as enemies, when actually their interests are inseparably bound together. Both want the mill to run, and continued successful running can only be achieved by coöperation.

To be able to get such a transcript, one needs helpful connections with companies having wise leadership both in management and labor. At the present time there is altogether too little wise leadership in labor. Many new Unions have come into being with inexperienced leaders recruited from the intelligent sore-heads management could not promote because of their inability to coöperate.

The effect on the class of seeing what a difference it can make when both sides are genuinely trying to understand the other's issues and problems unemotionally, is amazing and deeply gratifying. At least for those who participate in the demonstration, it gets down to the level of feeling, particularly—as happened once this year—if the students do as good a job in the demonstration as the personnel man did in the actual case.

In order to be fundamental the student must not only be exposed again and again to the technique of a bilateral approach; in order to *understand* he must have a reasonable grasp of:

(*A*) Habit Psychology.
  You cannot undo by a posted notice, or in twenty minutes or in twenty days, habits that have functioned for twenty years.

(*B*) Psychology of Understanding.
  (1) Always in terms of old concepts;
  (2) Only small new increments possible;
  (3) Must be achieved between two individuals (groups do not think).

(*C*) Crowd Psychology.
  See Martin, E. D.: "Behavior of Crowds."

A crowd is not the sum of its parts, but the organization of its parts. Individual desires and control are greatly affected by the group one is in, especially if one belongs to the group. When the individuals in a group share a common strong desire (conquest, food, more profits, or higher wages) they tend to stimulate each other to a point where intelligent thought ceases. Then people merely repeat slogans, rouse emotions, and strive to vindicate their desires. All reasoning and reasonableness ceases. In such a group, it is easy to trigger off the common desire into a fixation of attention so that the group forms a crowd—or even a mob—which seeks an outlet, often illogical, illegal, and immoral, regardless of reason or ultimate consequences.

When the group becomes a crowd, individual censors are dulled and morality drops, because the crowd are all pulled in the same direction by some uncontrolled fundamental desire. Each person abandons his own standards and the members of the crowd go temporarily insane together. This applies to teachers, management, unions, conventions, even nations.

As an individual, the working man has amazing common sense and intuition. He cannot give the complicated arguments of college graduates. His conclusions are often just as sound. But modern economic and industrial conditions have become so complicated as to baffle the best of us. We are in the midst of the most gigantic economic and spiritual upheaval that has ever taken place, and during a period of transition the truth is particularly hard to find.

So the workman is baffled. He wants to trust somebody, but whom? Evidence from past treatment by management looks suspicious. Union leadership is less intelligent than business leadership because business pays so much better wages. The government has passed a lot of social security legislation, and then has handled the money in a way for which any private management would be jailed.

The most unhappy thing about industrial relations is that so often a result earnestly desired by both sides cannot be realized because of mutual misunderstanding arising from suspicion, distrust, and jealousy.

Management must *deserve* labor's trust. This is not a matter of welfare work or of politics, but a matter of sincerity, fairness, and of plain old-fashioned morals. These are unhappily out of fashion right now, despite which in the long run insincerity and duplicity always lead to harm.

It should be apparent from the foregoing that I feel all three of us have made grievous mistakes. Management has for a cen-

tury "left undone those things which it ought to have done" and failed to see that good profits depend on good men who derive from good labor relations. Labor put its trust in management, and when betrayed by the crowd psychology of management, developed a crowd psychology of its own which at this very moment is as ruthless and selfish as that from which labor wished to escape. Teaching has embraced a lot of answers before it even knew the right questions to ask. "The idea that falsehood is edifying is one of the besetting sins of educational schemes." We have not been fundamental in our approach and have all too often fanned the flames of class hatred. We are just as stupid and lazy and mistaken as anyone else, perhaps more so, because there is no fool like a well-schooled fool.

We have been contented to put our efforts into teaching the subject instead of into teaching the student. We say "This is what he ought to know," instead of finding out what he as an individual needs to know. Let me quote from a letter written by my daughter, herself a college Junior. "It should be more widely recognized that college students are not mature. They need teachers who are philosophical and friendly; who have found out how to live wisely themselves in a coöperative world and who can help show the students how to go about learning to do it. No study is of much value until one has a background of wisdom which makes one right with one's self, one's fellow workers, and one's God. So many students do not know that they are wrong with themselves, and it takes a real teacher to see it and to show them. Learning to live is largely a matter of learning to understand, first ourselves, and then those who are different or who differ from ourselves."

Above everything else, a real teacher of industrial relations (and perhaps of anything else) will stimulate his students into personal growth. He will have the courage to confess that we have all been wrong. Patient trial and error is as inescapable for the social scientist as for the chemist. Our mistakes are inevitable and an integral part of our growth—so long as we have the integrity and the courage to recognize them.

The real teacher will give his students faith and zest for the future because of what we have learned from the past. He will leave them with a restless appetite to reach out and try to use what they have learned. Then their personal problems will fall into the right perspective and despite the fact that many of our present ways of living are now being destroyed, despite the fact that we can only look forward to living in a ravished world, from the ruins we shall still achieve high goals if destruction can be followed by a coöperative effort to do the things that are of value to ALL of us.

RELATIONS BETWEEN THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF CALIFORNIA AND THE JUNIOR COLLEGES OF THE STATE *

By RAYMOND E. DAVIS

Director, Engineering Materials Laboratory

Since the inception of the junior college movement in California thirty years ago there has always been the closest coöperation between the junior colleges and the University. During the early stages of their development, advanced standing to the University was granted only for approved courses taken in specific junior colleges. For almost twenty years it has been the policy of the University to admit students to advanced standing from all of the public junior colleges of the State on substantially the same basis as students have been admitted from those four-year colleges whose standards have been regarded as comparable with those of the University of California, and full credit in advanced standing has been granted for work of collegiate grade satisfactorily completed in the junior college. There has been no attempt on the part of the University to dictate to the junior colleges what they shall teach or how it shall be taught. These years have witnessed a tremendous growth in the junior college movement, not only as regards the number of institutions but also as regards the number of students who continue their education beyond the high school level in these institutions.

While during the earlier years the principal function of the junior colleges was to prepare students for more advanced work in four-year colleges, today the junior colleges are primarily terminal institutions, and the preparatory function has become secondary.

In California, the junior college has become an established institution, which has met in a thoroughly satisfactory manner a very definite need for secondary education on the post high school level; and a good many of the junior colleges are meeting in a thoroughly satisfactory manner the problem of providing general education on the lower division level for those who intend to continue such general education in our four-year colleges of arts and sciences. Fewer in number are those who have the facilities and personnel for the adequate lower-division training of students in Engineer-

* Presented at the 48th Annual Meeting, S. P. E. E., University of California, June 24–28, 1940.

ing. Nevertheless, there are several junior colleges which, from all the evidence at hand, offer training to lower-division engineering students which in every respect meets our University standards for lower-division courses of the engineering curricula. If we except these institutions, it is still our contention, borne out by studies, that any young man who can afford to do so should transfer to our College of Engineering not later than the end of the freshman year. However, a goodly number of our more brilliant students receive all of their lower-division training in junior colleges where the standards are substantially lower than those of the University, and it seems to be the case that the brilliant student will succeed regardless of whence he came or of what was his previous preparation.

In California, as elsewhere, many of our deserving engineering students come from poor families, and the junior colleges in general fill a real need in providing these young men with lower-division engineering training at a low cost, since by attending junior college many are able to live at home. The tragedy comes among those of relatively low scholastic ability, many of whom were not eligible for admission to our College of Engineering at the time of high-school graduation, who according to the standards of a particular junior college may have satisfactorily completed lower-division engineering courses, only to find after a semester in the University upper division that they are totally incapable of meeting our standards. In many of the junior colleges, the classes may contain a high percentage of those not eligible for admission at the time of high-school graduation but ambitious to be engineers though lacking in the necessary intellectual ability as measured by our standards. Under these conditions, with anything like a normal distribution of grades, there is not the weeding-out process, separating the fit from the unfit, that takes place in our own lower-division courses. It is a great disappointment for a young man who has made what he considers a fairly good record in a junior college for two years to fall so low in scholarship at the end of the first semester of the junior year in our College of Engineering that he is dismissed from the University. Yet this is exactly what happens in many cases of transfer students from junior colleges where the grading standards are low or where the advisory system is apparently weak.

At the University of California practically all students gain admission in freshman standing by certificate from accredited high schools, of which there are more than five hundred in the State. For admission by certificate to freshman standing in the College of Engineering and the College of Mining, the requirements are as follows:

High School Subjects:

(*a*) History		1 unit
(*b*) English		3 units
(*c*) Mathematics		4 units
	Elementary Alegbra	1 unit
	Plane Geometry	1 unit
	Algebraic Theory	1 unit
	Trigonometry	½ unit
	Solid Geometry	½ unit
(*d*) Science		2 units
	Physics	1 unit
	Chemistry	1 unit
(*e*) Foreign Language		2 units
(*f*) Geometrical Drawing		1 unit
(*g*) Electives		not less than 3 units
Total		not less than 16 units

High School Scholarship:

"B" average in the last three years of high school with no grade less than "C" in any required subject.

Deficiencies in the subject or scholarship requirements for admission in freshman standing by certificate may be removed in a variety of ways, but the large percentage of high school graduates who have such deficiencies and who desire to enter the University of California, attempt to remove these deficiencies and at the same time gain advanced standing by work undertaken in one or another of the 60 junior colleges or the seven state colleges.

By state law, public junior colleges are required to admit any high-school graduate, regardless of scholarship grades or subjects. Students who remove matriculation deficiencies in this way must remain in the junior college or state college long enough to remove the entrance deficiencies, and in addition, must complete at least 15 units of collegiate subjects with a grade point average of not less than 1.5 (A = 3, B = 2, C = 1, D = 0, E = −1) or must remain until 60 units of collegiate work have been completed with a grade point average of not less than 1.0 (C).

Because of the wide geographical distribution of the junior colleges and state colleges, many high-school graduates eligible for admission to the University attend junior colleges or state colleges for one or two years because it is cheaper and because they can live at home. Such students may transfer to the University at any time provided their grade-point average for work of collegiate grade undertaken in the junior college is not less than 1.0.

Thus there are admitted in advanced standing to our Colleges of Engineering and Mining at Berkeley many students who *were not* eligible for admission at the time of high-school graduation and

also many who *were* eligible for admission at the time of high-school graduation. Some transfer after one semester at the junior college, and some after a year, but by far the larger number come to us with junior standing. Thus, while for colleges of engineering in general, the lower division enrollment is much higher than that in the upper division, at the University of California, the reverse is true, as shown by the values in the following table:

ENROLLMENT, FALL, 1939

Class	*Number*	*Per cent*	
Freshman	436	21	
Sophomore	391	19	40
Junior	654	31	
Senior	501	24	
Graduate	111	5	60
TOTAL	2,093	100	

The conditions just described create a variety of administrative, teaching, and guidance problems. Because of the marked difference in standards that exist among the various junior colleges, grades from junior college *A* have not the same meaning as those from junior college Z, either as an index to the scholastic ability of the student or as to the degree of mastery of a subject.

At junior college A the classes in engineering mathematics may be open only to those who were eligible for admission to the University at the time of high-school graduation or to those who in other courses in mathematics taken in the junior college have demonstrated their ability in this field. In junior college Z, classes in engineering mathematics may be open to all high school graduates who have taken the prerequisite courses in high-school mathematics, regardless of the grades received. The standards in courses in mathematics of junior college A are almost certain to be much higher than those of junior college Z. Students from junior college A may be as well prepared for more advanced courses in engineering as our own lower-division students. But an unduly large percentage of students from junior college Z will fail, and only those of more marked intellectual ability are likely to do satisfactory work in the more advanced courses in engineering.

The problem is particularly acute during the first semester of our junior year, partly because of the large number of transfer students who enter the College of Engineering as juniors and partly because of the general character of the junior curricula, but more particularly because of the widely varied preparation of students and the equally wide variation in their mental ability. As might be expected, among the students transferring from certain junior

colleges the percentage of failures in basic engineering courses of our junior year is high.

The complexion of our junior classes over a period of years is indicated by the values in the following table:

TRANSFERS FROM OTHER INSTITUTIONS IN THE STATE TO THE FIRST SEMESTER JUNIOR YEAR

Institutions	5 year Period	4 year Period	Per Cent of Entering Juniors	
	1932–1936	1936–1939	1932–1936	1936–1939
40 junior colleges	546	629	41	44
7 state colleges	139	144	10	10
8 private four-year colleges	41	29	3	2
Berkeley, U. C.	458	450	34	32
Los Angeles, U. C.	151	168	11	12
TOTALS	1,335	1,420		

It should be emphasized that the table includes only those who were admitted in junior standing to the College of Engineering from junior colleges, state colleges and private four-year colleges in California, and those who were admitted in advanced standing to the freshman or sophomore years are not included. It will be noted that during the period 1936–39, 44 per cent received lower division training in 7 state colleges, 12 per cent transferred from the University of California at Los Angeles, and only 32 per cent took their lower division work in the College of Engineering at Berkeley.

For a number of years it has been our practice periodically to prepare scholarship records of transfers from individual institutions, including junior colleges, state colleges, and private four-year colleges, and to compare these records with similar records of students who entered the University of California as freshmen. For each institution, these records show the number of transfers to junior standing, the lower-division grade-point average of the group, the grade-point average of the group during the first semester of the junior year, the difference between the lower division and the first semester junior-year grade-point averages (designated as the "grade-point differential"), and the percentage of the group who failed to maintain a C average during the first semester of the junior year. This is done for individual departments as well as for the College of Engineering as a whole. The information has been found to be of value first as a a means of comparing our own standards with those of other institutions, second as a means of

predicting the probable success or failure of those who seek to transfer from the various institutions on the list, third as information for our advisors in dealing with individual students on registration and other matters, fourth as information for junior college administrators, and fifth as material for discussion in conferences between representatives of the junior colleges and the University. The material in the following table has been abstracted from these records for two periods, 1932–36 and 1936–39.

SCHOLASTIC RECORDS OF INSTITUTIONS FROM WHICH TEN OR MORE STUDENTS TRANSFERRED TO THE FIRST SEMESTER, JUNIOR YEAR

	Period Entering Upper Division	California Lower Division	Junior Colleges			State Colleges			Private Colleges Aver.
			High	Aver.	Low	High	Aver.	Low	
Lower Division Gr. Pt. Aver.	1932–36	1.48	1.80	1.63	1.35	1.92	1.63	1.51	
	1936–39	1.48	1.93	1.75	1.49	1.96	1.86	1.60	1.50
First Semester Jr. Year Gr. Pt. Aver.	1932–36	1.33	1.60	1.06	0.78	1.32	1.12	0.67	
	1936–39	1.33	1.75	1.16	0.71	1.35	1.33	1.08	1.09
Grade Point Differential	1932–36	0.15	−0.09	0.57	0.80	0.26	0.51	0.87	
	1936–39	0.15	−0.25	0.59	0.85	0.33	0.51	0.88	0.41
Per Cent Below "C" Average First Semester Jr. Year	1932–36	31	18	42	67	26	38	57	
	1936–39	32	10	36	55	32	35	39	32

The table is designed particularly to show the wide variation in the scholastic performance of groups of students from individual institutions. In the columns headed "Average" are average values for all junior colleges or state colleges. In the columns headed "High" or "Low" are given values for individual junior colleges or state colleges which on the basis of the particular quantity under consideration was respectively above all others or below all others. Thus junior college A might be high as regards the lower-division grade-point average of its transfers, junior college B might be high as regards the grade-point average of its transfers for the first semester after entering the University, junior college C might head the list as regards grading standards as indicated by the magnitude and sign of the grade-point differential, and junior college D might be high by reason of the fact that the percentage of its transfers who failed to maintain a C average was less than for any other junior college.

Considering averages, the lower division grade point average of those entering our upper division from junior colleges and state

colleges has been consistently much higher than the lower division grade-point average of those who were trained in our own lower division. This difference was more marked for the later period (36–39) than for the earlier period (32–36). The first semester junior year grade-point average of those entering our upper division from junior colleges was substantially lower than was this grade-point average for students from our own lower division, though the difference was considerably less marked for the later period (36–39) than for the earlier period (32–36); for state college transfers, the first semester junior year grade-point average equalled that of students from our own lower division during the later period (36–39), but was substantially less than that of students from our lower division during the earlier period (32–36).

It seems fair to assume that this general improvement of the scholastic achievement of transfers from these institutions has been due not so much to higher standards as to more careful student counseling on the part of junior and state college authorities. In other words, in the light of experience, counsellors have advised their students not to attempt the upper-division work of the College of Engineering at the University of California unless their grade-point average in the junior college or state college was sufficiently high to indicate their probable success in University work.

It is believed that the "grade-point differential" is the best single index to the standards of an institution. This quantity is obtained by subtracting the first semester junior-year grade-point average of the group transferring from a given institution from the pre-transfer lower-division grade-point average for the same group. Thus a positive differential indicates a lower grade-point average for the first semester after transfer than was obtained for work undertaken in the lower division; a negative differential indicates a higher grade-point average for the first semester of the junior year.

Again referring to the table and considering averages, the differential for the group trained in our own lower division was 0.15 for both periods, for those trained in state colleges it was 0.51 for both periods, and for those trained in the junior colleges it was 0.57 and 0.59 for those who enrolled in our College of Engineering during the periods 1932–36 and 1936–39 respectively. These values indicate that on the average the grading standards are somewhat lower for the junior colleges than for the state colleges, and that for both these groups of institutions the grading standards are on the average substantially lower than are those of the lower division of the University of California.

What has been said before applies to the junior colleges and state colleges as groups. The "High" and "Low" values in the

table are an indication of the wide differences that exist among individual institutions. It is these wide differences that give us much concern, that are the source of many of our difficulties. For example, while for junior colleges which sent us 10 or more transfers in junior status during the period 1936–39, the range in the lower division grade-point average among the various transfer groups was from 1.49 to 1.93, a difference of 0.44, the range in first semester junior-year grade-point average (a measure of scholastic ability) was from 0.71 to 1.75, a difference of 1.04. The range in grade-point differential (a measure of grading standards) was from 0.85 to —0.25, a difference of 1.10. And the range in the percentage below C average during the first semester of the junior year (a measure of lack of ability to do satisfactory work in the College of Engineering) was from 10 to 55, a difference of 45. It will be noted that among the state colleges, the range is markedly less than among the junior colleges.

The scholastic record of groups of students from 18 junior colleges for the periods 1932–36 and 1936–39 is shown in the following table:

SCHOLASTIC RECORD OF TRANSFERS FROM JUNIOR COLLEGES

Junior College	Grade Point Average				Grade Point Differential	
	Junior College		First Sem. Univ.			
	1932–36	1936–39	1932–36	1936–39	1932–36	1936–39
A	1.35	1.50	1.44	1.75	−0.09	−0.25
B	1.64	1.62	1.60	1.61	0.04	0.01
C	1.66	1.64	1.23	1.45	0.43	0.19
D	1.61	1.55	1.16	1.32	0.45	0.23
E	1.58	1.90	1.28	1.53	0.30	0.37
F	1.94	1.93	1.52	1.54	0.42	0.39
G	1.55	1.56	0.84	1.13	0.71	0.43
H	1.66	1.78	1.18	1.33	0.48	0.45
I	1.39	1.64	1.12	1.16	0.27	0.48
J	1.73	1.80	1.31	1.24	0.42	0.56
K	1.49	1.63	1.00	1.07	0.49	0.56
L	1.80	1.68	1.22	1.11	0.58	0.57
M	1.57	1.72	1.09	1.14	0.48	0.58
N	1.42	1.51	0.98	0.91	0.44	0.61
O	1.61	1.64	1.13	0.95	0.48	0.69
P	1.61	1.49	1.00	0.71	0.61	0.78
Q	1.47	1.54	1.02	0.72	0.45	0.82
R	1.79	1.71	0.43	0.86	1.36	0.85

In none of the groups was the number of students for either period less than 10. For the earlier period, the lower division

grade-point average for 16 of these groups was higher than that of the corresponding group of those taking their lower division work in the University, but only two of these groups maintained a higher grade-point average during the first semester of the junior year than did the group previously trained in our lower division. For the later period, groups from 4 of the junior colleges maintained a first semester junior year grade-point average higher than did those coming from our own lower division. For each of the two periods, the grade-point differential was less for groups from two of the institutions than for the group trained in our own lower division. During the period 1936–39 six of the junior colleges sent us groups of students for which the percentage falling below a C average for the first semester of the junior year was less than the corresponding group trained in our own lower division.

From these comparisons it appears that 16 of the 18 junior colleges which send us considerable numbers of students have standards that are lower than those of the University of California, that 14 send us students who on the average exhibit scholastic ability inferior to that of the average student trained in our lower division, and that two-thirds of the junior colleges send us transfer groups that are less capable of doing satisfactory work as measured by the C average grade. It ought to be explained that in the College of Engineering, a student who fails to maintain a C average at the end of any semester is subject to dismissal.

One naturally inquires whether or not there has been an improvement either in the quality of students coming from individual junior colleges or in the standards of individual institutions. A study of the table shows that for the period 1936–39 the first semester junior grade-point average was higher for 12 of the 18 junior colleges than it was during the earlier period. But for the period 1936–39, the percentage of those who failed to maintain a C average was higher for 9 and lower for the remaining 9 than for the earlier period (1932–36). A study of the grade-point differentials for the various junior colleges similarly indicates that while for some institutions the differential was less for the later period, for an equal number of institutions the differential was greater.

For a good many years there has existed what we call the Junior College Conference Committee, which is made up of representatives of the University and of the public junior colleges of the State. The function of this committee is to consider problems of mutual interest. Meetings are held periodically for the purpose of discussing such problems. It is not a policy-making body, but through its deliberations and discussions, the University is kept informed of what is happening among the junior colleges, and vice

versa. Through the mutual exchange of ideas the University has come to have a better understanding of the problems of the junior colleges and the junior colleges have come to have a better understanding of the problems of the University.

During the past ten years it has been the practice of the University annually to transmit to junior college administrators records of the scholastic achievement of groups of their transfer students for the preceding three years. These records are not segregated as to colleges of the University, but are for transfers to the University as a whole. In this way the junior college administrators are kept informed as to the performance of their groups of former students who have entered the University of California with advanced standing. This information has naturally had its effect on the junior colleges as a group. If a junior college principal sees that the performance of his students in the University has been poor as compared with that of students from other junior colleges, he is likely to take steps to improve this condition. The result has been a gradual improvement in the average quality of junior college students as measured by their all-university record, though, as has been indicated, there has not been a corresponding increase in quality as measured by the records of students who transfer to our College of Engineering. Among individual junior colleges there are, of course, exceptions to this statement. What has been said applies to the junior colleges as a group.

In the last analysis, the University and the junior colleges have the same objective—which is that every student should be given the educational opportunity to which his talents entitle him. The University does not take the view that the standards of a junior college, in so far as they affect those who transfer to the University is concerned, should necessarily be as high as those of our own lower division, but it does take the view—and this view is shared by junior college administrators in general—that, relatively, there should be no more failures among transfers from any junior college after they reach our upper division in the University as a whole or in any part thereof, such as the College of Engineering, than there are among those who receive training in our own lower division. Of course, this does not refer to normal year-to-year variations such as must always be expected when the number of cases is limited, no matter by what system or with what care selections might be made; but it refers to consistent year-after-year performance by which the product of a given institution may be judged as good or poor, moving upward or downward on the scholarship scale.

The question of how best to cope with this problem has been under perennial discussion by the membership of the Junior College

Conference Committee. As stated earlier, any student is admitted to the University and to our College of Engineering from any public junior college in the State if his record in academic subjects taken in the junior college is not less than a C average (students not eligible for admission to the University at the time of high school graduation must present not less than 60 units of such work taken in the junior college in order to be admitted under the C average rule).

For a number of years it has been the practice of the University to require of transfers from private junior colleges, as well as from four-year colleges, whose grading standards have been shown by experience to be substantially lower than those of the University, a grade-point average greater than 1.0. For example, if for a period of years the grade-point differential of the group of students from private junior college A were 0.75, it might be required that transfers from that institution have a grade-point average of not less than 1.5. In other words, there would be enforced against that institution a differential of 0.50. This scheme of differentials has operated quite effectively to bar unqualified private college students from attempting more advanced work in the University. It is a scheme that has been applied for a considerable period by Stanford University in its selection of applicants for admission from public as well as from private junior colleges. It is felt that if this plan of enforcing differentials could be placed in operation by the University of California against *public* junior colleges, it would do much towards eliminating many of our present difficulties. A considerable number of junior college administrators concur in this view, but there is probably a larger number of administrators who object to the plan, feeling that in the mind of the average layman a differential would be construed as meaning that the junior college was an inferior institution. Members of this latter group generally take the view that their students who are lacking in ability to do advanced work in the University of California, by proper advice from their counsellors, may be discouraged from attempting to continue their education in the University, even though their grades are sufficiently high to make them admissible. Undoubtedly many, if not all, of the junior-college administrators who hold this view are making a sincere effort to control the problem through their student counsellors. But here the personal equation enters, and even if proper advice is given by the junior college counsellor, there is no way of making the student follow the advice. If a young man has made up his mind to enter the College of Engineering of the University of California, and has taken the prerequisite subjects and has obtained the necessary grades in the

junior college, the advice of his counsellor that he should not make the attempt because of lack of aptitude may go unheeded.

When during the four-year period 1936–39 more than 50 students from each of two junior colleges transfer to the upper division of the College of Engineering and the first semester junior grade-point average for one group is 1.75 and for the other 0.72, and when the grade-point differential for the first of these two institutions is — 0.25 and for the second 0.83, it seems hardly fair either to the students or to the institutions concerned that the transfers from these two colleges should be admitted to our upper division on exactly the same basis—it seems to be positive proof that the present rule of admitting on the basis of the C average grade cannot be made to work effectively.

As Chairman of our University Committee on Junior Colleges, and as a member of the Junior College Conference Committee for more than 10 years, it has been my privilege to come in rather close contact with junior college administrators and their teaching staffs. I find these men quite generally to be of broad vision and progressive mind, and to them goes all credit for a development in education of which the people of the State may be justly proud. Nothing I have said is intended to cast reflection upon the junior colleges as a group. The problems which I have mentioned are joint problems between the University and the junior colleges. There are differences between junior colleges, but these are no greater than between colleges of engineering in our state universities. Rome was not built in a day. Improvements come slowly; they come by looking ahead in the light of what has gone before. Because of the open minds and progressive attitudes of those who guide the destinies of the junior colleges in the State of California, I look forward with a good deal of confidence to the eventual elimination of most of the inequalities and difficulties that I have pointed out today.

UNIT OPERATIONS APPARATUS IN MECHANICAL LABORATORY INSTRUCTION *

By R. A. SEBAN

Instructor in Mechanical Engineering,

Mechanical Engineering, University of Santa Clara

In this paper, the author proposes to consider the application of the unit operations principle in mechanical laboratory instruction. To this end a few types of apparatus for instruction on this basis will be illustrated and the accompanying experimental work discussed. A preliminary consideration of the unit operations concept will aid in establishing the position of this type of laboratory exercise.

A group of the branches of knowledge, developed by application of the basic ideas of physics to explain the behavior of natural systems, encompasses the field of mechanical engineering. These branches are defined as unit operations. They are (with some subdivisions included),

Heat Transfer (conduction, convection, radiation),
Thermodynamics (paths, cycles, energy transformation),
Mechanics and Thrusts (isothermal flow, lubrication, acoustics),
Mechanics of Solids (statics, dynamics, vibration),
Elasticity (stability, vibration).

Certain combinations of these primary unit operations are of sufficient importance as factors of physical systems to warrant special consideration as secondary unit operations. Some are: Separation, humidification, combustion, drying.

It is evident that the unit operations concept forms a convenient and useful classification of engineering experience. The contribution of the laboratory to this experience can best be made on a unit operations basis.

Examination of laboratory objectives indicates agreement on development of ability in organization, mensuration, and report writing, while illustrating principles basic to the field of engineering and demonstrating the characteristics of engineering apparatus. The integration of the student's laboratory experiences should

* Presented at the 48th Annual Meeting, S. P. E. E., University of California, June 24–28, 1940 (Mechanical Engineering).

combine with his other engineering background to assist in the solution of problems.

Examination of the method of solution of complex problems indicates an initial construction of an idealized system approximating the actual system of the problem. This ideal system is composed of many unit operations. The unit problems in these operations are solved from previous experience by means of ideas common to all engineering. The combination of the solutions indicates the behavior of the actual system with an accuracy depending upon the approach of the ideal system (thought model) to the actual system. The laboratory experiences of the student should assist him in making this synthesis of unit operations problems.

This contribution can be achieved by experiments on simple systems, involving a minimum number of variables, before proceeding to complex systems, such as machines and processes. The analytical verification or prediction of the experimental results, which is considered to be part of the experimental method, is readily accomplished for the simple systems, whereas it involves a synthesis of many unit operations in the complex system. Such synthesis predicates the experience gained on the unit operations demonstrated in the simple systems.

The unit operations experiment considers a single problem, involving one solution of the differential equation of the system. The construction of the apparatus conforms to the idealized system used in the analysis as closely as possible, to allow accurate predictions of the results. Since commercial equipments rarely satisfy these requirements, special apparatus is necessary.

Any problem in the field of a unit operation may be used as an experiment. Those most informative and presenting the opportunity for widest generalization are the most acceptable for experimental solution in the laboratory. Examples of such problems are: temperature distribution along a long, thin rod; the shape factor for a buried pipe line; heat transfer by convection in a single pipe heat exchanger; mass and heat transfer from a wet bulb thermometer; determination of the friction factor for a journal bearing; application of instruments to an apparatus producing a periodic variation of the measured quantity, etc.

Some of the requirements for apparatus of this type will now be considered. The following groups are not independent but are primary considerations in the construction of unit operations apparatus.

1. The arrangement of the equipment should illustrate an application of the unit operation. The modifications required for convenient measurement of the variables and approximation to the

assumptions in the analysis should be achieved in a manner that resemblance to the actual system remains. If this is not possible, the application should be developed for the student, for, as an engineer, he desires to work with systems of engineering significance.

2. The fundamental principles involved must be illustrated quantitatively. The apparatus must be more than a demonstration model. The accurate measurement of the variables must be possible and the results must be presented so as to secure the maximum applicability to other systems. Analogies should be emphasized and all generalized correlations developed.

3. Visual demonstration of the characteristics of the operation should be provided whenever possible. Observations of the mode of vibration of a beam by stroboscopic illumination, or of the type of fluid flow by injection of a visible element into a fluid stream offer indications of the extent to which the assumed idealizations are realized in the apparatus.

4. The instruments must provide for the measurement of the variables with reasonable accuracy. It is desirable to require, in a preliminary report, an analysis of an idealized system, corresponding to the actual system, predicting the results to be obtained. The laboratory results, if they check, will foster confidence in the analytical and experimental method presented.

5. As many methods as possible should be employed for measurement of the variables. Continual contact with the problem of instrumentation will widen the concept of accuracy and error and aid in the evaluation of the data obtained.

6. The apparatus must be sufficiently small to be economical to operate, yet large enough so as not to resemble a toy. The low capital cost of equipment of this character permits its use in large amount, thus making for a flexible laboratory.

These criteria are partly realized in the illustrations of unit operations apparatus that follow. They are equipments for solution of problems in Heat Transfer and Vibration, and for the demonstration of the effect of the dynamic characteristics of pressure measuring instruments on their indication. This latter refers to the field of mensuration, which involves all of the unit operations as they affect instrumentation.

Heat Transfer by Conduction

The performance of many systems in which heat transmission by conduction is important may be approximated by the idealization of a long, thin rod, heated at one end and losing this heat by leakage along its length. Familiar examples are valve stems, cool-

ing fins, handles on heated equipment, and buried pipe lines carrying a heated fluid. The heating may be either steady or periodic.

The analytical solution of the problem of the infinitely long, thin rod indicates the temperature of the rod as an exponential function of the distance from the heated end.

$$\frac{t}{t_0} = e^{-\sqrt{tp/ka}\,z} \Big]^*$$

This is for steady, non periodic, heating.

The slide shows a section of an apparatus designed for experimental solution of the problem of the temperature distribution along a thin rod. The rod is 3/8 in. copper, 4½ ft. long, and is

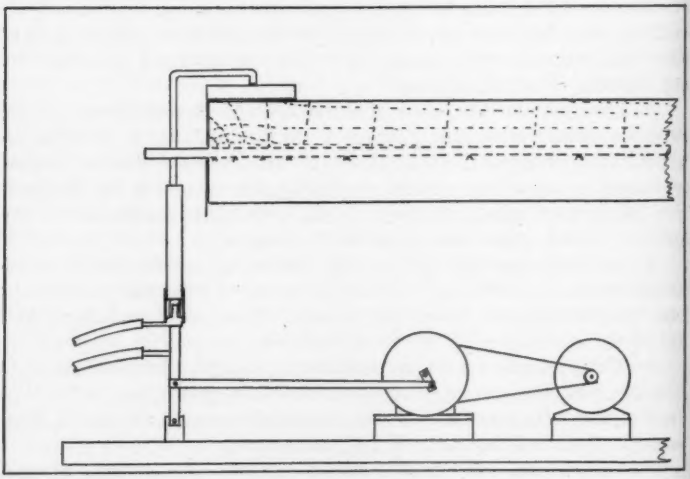

FIG. 1. Long thin rod.

covered with 85 per cent magnesia having an outside diameter of 4½ in. Thermocouples are placed along the length of the rod in an approximately logarithmic distribution, the greater number near the heated end. A motor and reduction gear-crank mechanism beneath the rod permits oscillation of the Bunsen burner heating the rod to induce periodic temperature variations when desired. In this case water is applied to the end of the rod when the burner is withdrawn to increase the amplitude of the temperature variations produced.

For the study of the steady state, non-periodic case, the tem-

* Preston, "Theory of Heat," p. 598, Macmillan, New York, N. Y., 1929.

perature of the rod is determined as a function of the distance along the rod and the gradient obtained is compared with that indicated by analytical consideration of the infinitely long, thin rod. The correlation obtained indicates the applicability of the results obtained for the infinite rod to rods of finite length.

The accuracy of this correlation depends upon the construction of the apparatus. In this rod the insulation is of sufficient thickness to produce about 90 per cent of the resistance between the surface of the rod and the surrounding air. A slight error in computation of the outside surface transfer factor is inconsequential and the overall conductance, computed on the basis of radial flow through the magnesia, is accurate enough to produce correlation with the experimental results. The assumption of radial flow can be justified by temperature measurements of the surface of the lagging, which indicates a flow pattern similar to that shown in the slide, deviations from the radial pattern occurring only at the heated end.

The problem of periodic heating may be treated as a combination of the average temperature gradient along a thin rod and the temperature distribution within a semi-infinite solid with surface temperature a function of time. The laboratory problem consists in operation of the apparatus with periodic temperature variation and in obtaining data giving the temperature along the rod as a function of distance and of time. The equation of the temperature in terms of these variables is determined for the fundamental of the temperature variation at two or more positions along the rod by means of a harmonic analysis of the data obtained. The damping of the temperature wave and the wave velocity are compared with the values predicted by analysis using the tabulated physical constants of the copper and the established period of the burner oscillation.

The importance of the periodic case is apparent from consideration of the problems of heat transmission in cylinder walls, regenerative heaters, and into the earth due to the diurnal temperature variation.

The next apparatus is designed for experimental solution of a steady state heat conduction problem. It demonstrates the use of the electrical method for determining the shape factor and hence the rate of heat conduction from a buried pipe line.†

An analysis of the problem by the source and sink method indicates that the heat flow from a line source within the ground to the surface of the ground will be $q = \dfrac{2\pi k t_L}{\ln 2D/r}$, where t_L is the tem-

† "Supplementary Notes on Heat Transfer," Boelter, Cherry and Johnson, University of California Press, Berkeley, Calif., page vii + 8.

perature of the line, measured above the surface temperature as datum, D is the depth of the pipe below the surface, and r is the radius of the pipe, assumed very small in comparison to D. By considering the surface of the pipe as an isothermal surface and determining the position of the line source in reference to the center of this surface, the equation may be written more accurately for

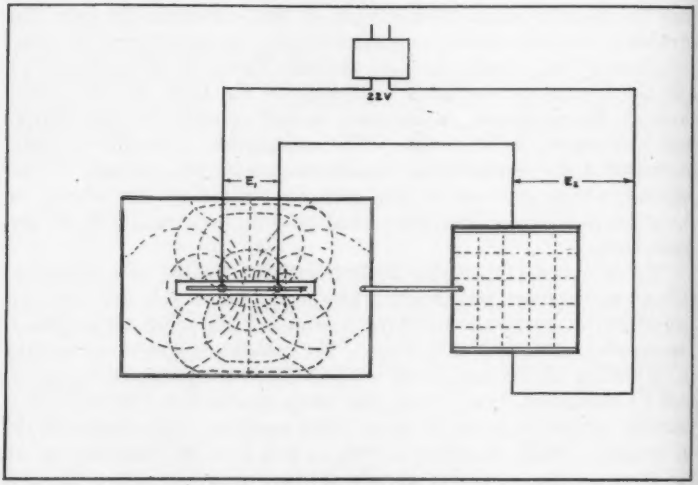

FIG. 2. Buried pipe line.

the case in which the radius of the pipe is of significant magnitude in comparison with the depth of its center line below the surface, as

$$q = \frac{2\pi kt}{\ln (D/r + \sqrt{(D/r)^2 - 1})}$$

or

$$q = \frac{2\pi kt}{\cosh^{-1} D/r}.$$

The shape factor is defined as $\delta = \frac{q}{kt}$, the ratio of the overall conductance to the unit conductivity.

$$\therefore \quad \delta = \frac{2\pi}{\ln 2D/r}.$$

The apparatus for the determination of the shape factor by the electrical method is relatively simple. Two pans are filled with an

electrolyte which is maintained at an equal level by an equalizing tube. One pan contains electrodes extending over the width of the pan on opposite sides; this is the comparison pan, the shape factor of which is the width of the electrodes divided by the distance between them. The second pan contains two copper cylinders standing vertically in the pan. The distance between the cylinders may be varied. The second pan must be of sufficient size that the sides of the pan do not significantly distort the flow lines between the cylinders.

A potential of 24 volts, A.C., is applied across the electrodes of the two pans, connected in series. The shape factor between the cylindrical electrodes is the shape factor of the rectangular arrangement multiplied by the ratio of the potential drop across the rectangular pan to the potential drop across the cylindrical electrodes.

$$S_1 = S_2 \frac{E_1}{E_2}.$$

The shape factor between one electrode and the neutral plane, corresponding to the shape factor between the buried pipe line and the ground, is twice the factor between the cylindrical electrodes. In the experimental investigation, two sizes of electrodes are used, with various distances between the electrodes, so that a wide range of D/r ratios is secured. The shape factors determined are plotted as a function of the D/r ratio and compared to the predictions of the analytical solutions already given. The experimental results agree with the more accurate equation to ratios of 4, when the predictions of both equations coincide. Above this value, the shape factors obtained using the larger set of cylinders deviate from the analytical curves due to the effect of the sides of the pan in distorting the flow pattern.

It is to be noted that a combination of the idealization of this experiment and of the infinite thin rod will produce a solution of the problem of a buried pipe line carrying a heated fluid.

Heat Transfer by Convection

The two preceding examples presented means for laboratory verification of results indicated by analysis from first principles. The next serves as an introduction to free and forced convection, verifies analytically predicted temperature gradients and permits determination of film transfer factors for comparison with accepted results.

The apparatus consists of a 1 inch brass pipe, 10 feet long, extending through a tank filled with water. Water, or other fluids, may be circulated through the pipe. Heat transfer takes place by

forced convection to the pipe wall, and from the exterior surface of the pipe to the water surrounding the pipe, by free convection. A centrifugal pump circulates the forced convection fluid through a closed circuit, consisting of the tube, an orifice meter, and a heat exchanger.

A pair of four junction copper constantan thermopiles in mixing pots at entrance and exit sections of the tube enable determination of the amount of heat transferred. The temperature gradients of the fluid within the tube and the tube surface along the flow

FIG. 3. Heat transfer by free and forced convection.

path are determined by thermocouples measuring average temperatures at points along the tube.

Because of the time required to attain steady state conditions only two flow rates are usually used per experiment. The data obtained enable computation of the film transfer factors, which are compared with accepted values by Re., Nu., Pr., and Gr. Modulli. A semi-logarithmic plot of the temperatures measured along the tube results in a straight line, verifying the predicted nature of this relationship.

Contemplated modifications will make this apparatus conform more closely to the criteria mentioned at the beginning of this paper. Instrumentation for pressure drop measurements will en-

able application of fluid flow—heat transfer analogies and complete insulation of piping and the heat exchanger will permit determination of a heat balance on the apparatus.

Dynamics

The problem of mechanical vibrations is an important part of the unit operation of mechanics of solids. Laboratory introduction is afforded by the examination of a system vibrating with a single degree of freedom.

The apparatus consists of a D.C. motor centrally mounted on a fixed ended beam, the beam dimensions being so proportioned that the sectional moment of inertia in the vertical direction is much less than that in the horizontal. The beam is sufficiently stiff to prevent movement along the axis of the beam and hence movement of the motor is limited to vertical vibration. The vibration is produced by unbalance weights placed on flywheels at the ends of the motor shaft. Damping is provided by two dashpots mounted beneath the motor. Instrumentation consists of strobotac, dial gage, graduated scale encircling one of the flywheels, and meters for the measurement of electrical input to the motor.

In addition, a dynamic absorber consisting of two end-loaded units may be attached to the beam below the motor. This may be tuned to the desired frequency by varying the position of the end weights on the absorber beams.

Analytical predictions of amplitude of vibration and phase angle, as functions of frequency, are required for vibration with one and with two dashpots connected to the beam. Solution of the familiar differential equation of the single degree of freedom system containing concentrated mass, compliance and damping, with a sinusoidally applied exciting force, yields these results.

The dimensions of the beam system permit computation of the spring constant and concentrated mass (this involves application of the Rayleigh method to determine the center loading equivalent to the distributed mass of the beam). The damping constant is computed from the given dimensions of the dashpot construction, assuming viscous flow of oil through the dashpot holes. The exciting force is determined from the known weights and position of the unbalance.

The experimental measurement of amplitude of vibration and phase angle as functions of the frequency of motor rotation requires operation at speeds above and below the resonant frequency. Observation of the dial gage and graduated circle by means of the stroboscopic illumination provided by the strobotac yields these quantities. Runs are made with one and with two dashpots con-

nected to the beam. As a check on the assumed sinusoidal character of the vibrations, a run is made at constant speed, during which the beam displacement is determined as a function of the angular position of the unbalance. Graphical representation verifies the assumption and illustrates the lag between beam position and the angle of the unbalance.

The experimental results verify the predicted nature of the vibration amplitude and angle of lag. Some discrepancy is present, due possibly to failure of the idealization of viscous flow in the

FIG. 4. Dynamics.

dashpots of the actual equipment. An independent measurement of the damping constant would be desirable. Such a determination could be made by use of a device recording the free damped vibrations of the beam resulting from an initial displacement. This record would enable evaluation of the logarithmic decrement and consequently the damping constant.

The addition of the dynamic absorber to the main structure is primarily a demonstration of this method of minimizing vibration. The absorber is tuned to the observed resonant frequency and the reduction of amplitude of vibration is observed. Analysis of the two degree of freedom system presented by the combined damper and main beam structure is not required.

Desirable equipments, complementary to the vibrating beam, would demonstrate analogous systems in other unit operations. These are: series R–L–C circuit connected to an alternator; an acoustical circuit using a Helnholtz resonator, and mechanical systems demonstrating the torsional oscillation and whirl of a shaft carrying a central disk.

The final illustration is an equipment demonstrating the effect of the operation of mechanics on mensuration. The effect of the dynamic characteristics of pressure measuring instruments on their indication is demonstrated by their application to a reciprocating water pump, which raises water about 15 feet and discharges it to a weighing tank.

A Bourdon pressure gage measures discharge pressure, a mercury manometer suction pressure, and an engine indicator the pressure variations within the pump cylinder. The laboratory problem consists in observing the action of these instruments at various pump speeds. The oscillation of the manometer is not large, but the Bourdon gage oscillates with an amplitude as high as — 3.5 psi about the mean of 30 psi. The cards taken from the indicator begin to show pencil vibration at speeds above 270 r.p.m., as the low resonant frequency of the indicator systems is approached.

Calculation of the volumetric efficiency of the pump from the known pump dimensions, speed and the weighing tank measurements is required. Determination of the r.m.s. error of this result introduces the element of probability as it affects mensuration. Analytical verification of the observed dynamic characteristics of the instruments is not required.

This apparatus is but one of many used to demonstrate the dynamic characteristics of instruments. Others include:

1. Amplitude of vibration of a Bourdon gage needle as a function of the pressure frequency produced by a pressure oscillator.
2. Amplitude of vibration of a pendulum tachometer as a function of frequency when applied to a shaft having a velocity fluctuation.
3. The oscillation of a mercury manometer and computation of the damping constant from observations of the logarithmic decrement.

This review of types of unit operations apparatus has attempted to illustrate and describe some applications of the unit principle to undergraduate mechanical laboratory instruction. The experience provided in analysis by experimentation on such system leads to the synthesis of unit operations required for the explanation of the

complex systems presented by machines and processes. Experimentation on the complex systems should be introduced as soon as sufficient experience has been gained to permit this synthesis. These should lead to the thesis problem, in which the student may exercise the method developed by the laboratory problems.

It must also be noted that the experience of solving problems of a fundamental nature lends reality to all of the basic expressions of the behavior of ideal systems. The low cost and time economy of unit operations apparatus justifies a large amount of such equipment, which would produce close correlation between laboratory and recitation period work through combined analytical and experimental solution of unit operation problems.

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TYPES OF PHYSICS COURSES NOW IN USE IN PRE-ENGINEERING SCHOOLS*

By LYNN W. JONES

University of Redlands

I feel that a discussion on the actual changes which have taken place in our physics courses during the last few years and an outline of the types of courses now in use might be very beneficial. We might also raise the question as to whether we have made as much progress in the efficiency of teaching of physics as the engineer has made in increasing the efficiencies of communication, production and transportation. In these engineering processes the mastery of time has been the basic factor. Have we considered that factor seriously enough in our teaching of physics? Do our methods of completely scheduling all of the school work for a student teach that student this "Time Sense" which is so fundamental in engineering? Another deficiency which might exist in our physics courses is the failure to drill thoroughly the student in the principle of analysis, the ability to reduce a complex problem into its simpler or elementary factors. Of course we realize that the scientific method should be the basis of our physics teaching but one of the criticisms of the engineering schools might be that we fail to acquaint the student with the fact that the process of analysis does exist as one of the most important phases of engineering and that the student who learns to apply this principle the quickest is the one who makes the fastest progress in industry.

Physics as a science probably has had the greatest increase in subject matter and the least change in the general course arrangement of any of the physical sciences. Most physics courses seem to be largely under the influence of custom so that any changes that are made in those courses are made principally through the efforts of outside influences either in the necessity of other fields or the requirements of other institutions. As an example, we might notice that a few years ago it was felt that trigonometry was necessary for college physics. Then the medical schools demanded a course in physics without such a requirement and the physics teachers provided such a course even though it was done under protest. Likewise some of the engineering colleges have instituted the two

* Presented at the 48th Annual Meeting, S. P. E. E. (Physics), at the University of California, June 24–29, 1940.

year general course in physics and some of the liberal arts colleges as well as a number of the junior colleges have changed their courses to meet the demands of the engineering schools. These facts do not suggest that changes are undesirable but question whether changes should be made because of these outside influences or whether suitable changes in the material offered without changes in the course set-up can be made through coöperative understanding with the engineering schools.

I have investigated the present program of a number of colleges and junior colleges to see how their physics courses are arranged and to discover if possible the purposes behind such arrangements and learn what the advantages or disadvantages of such arrangements might be. I have found that there are five types of courses offered, four of them being general or conventional and the fifth one being heretic, if I may use the title that Dr. Stewart has given his course. These plans are as follows:

1. The TWO-YEAR PLAN in which two or three divisions of the subject are studied each year. This plan is followed by the University of California, Occidental College, California Institute of Technology, and most of the junior colleges in California. The reasons offered for the use of such a plan are: (*a*) that the subject matter of a general physics course has increased to such an extent that a substantial treatment of all of it in one year is beyond the realm of the average student and that the popular survey type of course is too superficial. (*b*) That because some of the engineering schools follow this plan other liberal arts and pre-engineering schools also use it. Probably most of the junior colleges have adopted the two year plan for this reason. (*c*) Some teachers feel that there is less wasted effort in this plan as compared to the others that follow.

2. The second plan deals with a general ONE-YEAR COURSE (with suitable separation of the liberal arts, pre-medical and engineering students) with advanced courses in heat, light, electricity and magnetism, radio and atomic physics. Such schools as Pomona College, La Verne College, University of Southern California, University of Redlands, and Pomona Junior College are following this arrangement. Arguments in favor of this plan are: (*a*) The students get a general perspective the first year and can go more deeply into the subjects of particular concern the following years. (*b*) This plan may eliminate time marking and lost motion particularly in the laboratory.

3. The third group uses the FIRST-YEAR for a GENERAL COURSE with an INTERMEDIATE COURSE the SECOND YEAR that covers the same field. Washington University at St. Louis uses a modification of this arrangement wherein the general course is given the

first year followed by a course in "Modern Physics" the second year. The idea of the second year is to give the students who cannot afford more than two years of physics an insight into what is going on on the frontiers of physics today. The students who go on the third year resume the systematic study under the title "Advanced General Physics." The principal arguments in favor of this plan are: (*a*) the review of the material of the first year enhanced by the work of the second year drives the principles of physics home in a more forceful manner. (*b*) That because of collateral mathematics, this plan is better balanced and less sketchy than the second plan mentioned previously.

4. THE UNIVERSITY OF MAINE PLAN shall be listed as the fourth one. This plan is trying out an arrangement under which the first year is given to all students, liberal arts, pre-medical and engineers. Common lectures are used with different laboratory experiments and problems. The second year is given to the engineers only and covers the same material as the first year. The advantages as offered by the University of Maine Physics Department are: (*a*) The students entering upon the second year already have a birds-eye view of the subject as a whole and are therefore in a much better position to appreciate the intermediate work. The students also have a better grasp of mathematics when the second year work comes to them. (*b*) The natural rivalry between the liberal arts students and the engineers stimulates all of the students and creates a high standard of work.

5. The fifth plan is followed at the University of Iowa where, in addition to the regular one year course of physics, SPECIALIZED courses in the separate divisions are offered without a general course and without prerequisites in mathematics. Results show that specialized courses can be successfully taught without the preceding general course and that the students are more interested in analysis than they are in a rapid review of the general field and thus specialized courses arouse more interest than the less profound general courses. I have introduced this idea of specialized courses in order that we might discuss the advisability of offering them in mechanics, strength of materials, heat and light to our engineering students without the necessity of covering many of the topics of a general course which may be of relatively little value to the engineers.

Before opening this subject for discussion I would like to raise the question as to the actual purpose of a general physics course with the hopes that we can decide which one of the plans I have outlined comes nearest to meeting that purpose.

Shall physics foster the intelligence and initiative of the student rather than force him to rely on his memory and mince with tech-

nical terminology which has become large with our great increase of subject matter? Should it paralyze the student's ability to assimilate by offering too much material or should it consolidate his studies on a firm foundation and thus empower him to extend those studies as the need arises?

Shall a physics course be practical? It becomes somewhat difficult to decide what is practical in our field of physics. We might say that those things are practical that the student will use in his future life and engineering work. If this is taken as a criterion we might argue that the average engineer does not use much of the mathematics we teach him in his work. Perhaps we should say that the student should be taught those things whose principles he may use in his thinking. From this standpoint the consideration of the term "Practical" drops out of our discussion.

Should physics teach students how to manipulate physical instruments and be a course in technique or should it be taught, in the words of A. E. Caswell, "To give the student a vital acquaintance with the more fundamental and important phenomena of physics, to make him aware of the physics of the universe in which he lives, and shall it teach him to reason from cause to effect"? If so, can these things be taught in a one year course or is a two year plan necessary?

In conclusion may I say that all of these questions have been raised in the hopes that our discussion of them might eliminate some of the unnecessary accumulation of knowledge by the student, might improve our teaching methods in engineering physics, might impress upon the student the value of time and the mastery of the scientific method. Perhaps, too, our discussion might lead to the reorganization of our physics courses so as to make them of more interest and value to the engineering student.

CIVIL ENGINEERING PAGE

Notes of interest for members of the Civil Engineering Division.
—Editor, F. W. STUBBS, JR., *Rhode Island State College, Kingston, R. I.*

L. G. STRAUB, *Chairman*
M. W. FURR, *Past Chairman*
EDWARD E. BAUER, *Secretary*
F. W. STUBBS, JR., *Editor*
H. E. DAVIS
J. S. DODDS

IS CIVIL ENGINEERING DIFFERENT?

BY IVAN C. CRAWFORD

Dean, College of Engineering, University of Michigan

Wherein does the civil engineering differ from the other professional departments composing the usual American engineering college? Are there any distinguishing characteristics outside of subject matter which set this department aside by itself? Activities of civil engineers in registration matters and in national professional organizations might well cause us to consider these questions.

Within the College. Those who have served on accrediting committees during the past few years will agree that curricula may be very good, ordinary, or poor regardless of whether these curricula are chemical, electrical, mechanical, or civil. In fact, all three grades may be found in the same college. The presence of rather meagre laboratory facilities will not prevent a satisfactory rating, although emphasis on laboratory work varies considerably among departments.

Uniformly, certain engineering departments appear to lay more stress on research work than others. Civil engineering research within university laboratories may not have been as extensive in recent years as research in several other departments—but it cannot be said that civil engineering is at the lower end of the scale in this respect.

The amount of enthusiasm possessed by the members of the staff is, as a rule, a fairly good index of the grade of teaching and research work. Occasionally a department suffers from the presence of a senior staff member or members who have lost interest in civil engineering. Even then the department may escape the classification of poor if there are junior members with ability to furnish leadership. Enthusiasm for a professional field, however, is not the property of any one division.

Teaching methods employed are not markedly different from those used in the other fields. It is claimed, without substantiation by convincing evidence, that superior teaching ability is generally found in civil engineering staffs.

So as we check down the list no really significant differences are found between these areas which compose the broad and constantly expanding field of engineering—that is, no differences except subject matter. Keep in mind, however, that we have been considering only the fraction of the area of civil engineering that exists within a college of engineering.

Outside the College. Stepping out now into the world of active practice we find a set of circumstances surrounding civil engineering which does in a way distinguish it from other engineering professions. Electrical, mechanical, chemical, and mining engineers have to do with production and in the main are employed by business interests. Electrical appliances, automobiles, rubber, and lead are produced to be sold. Civil engineers, on the other hand, are more frequently found in the employment of governmental bodies occupying positions with villages and counties, with cities and states, and in technical positions with the Federal government. The generalization that civil engineers are most likely found in governmental positions is probably true despite the fact that a large percentage of members of this group find employment in industry.

This difference in major source of employment probably causes many civils to view strictly professional matters through slightly colored lenses, and perhaps accounts for the more aggressive part played by them in the development of registration laws and in the emphasis they placed on professional objectives. Without doubt the viewpoints stressed by the practising civil engineer are rather generally accepted by teachers and are transmitted to upperclass students. Here then, to a minor extent, the personnel of the civil engineering department may possess characteristics not equally shared by other departments.

THE T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE
DIVISION OF ENGINEERING DRAWING

A. W. LEIGHTON, *Editor*, Tufts College

The Executive Committee of the Division of Engineering Drawing, together with invited members in the mid-west, held a meeting on September 28th to name committees and discuss plans for the year.

The Committee has begun work on the details of a plan for a National Study of Engineering Drawing which will be submitted to the Division next June for approval.

The Division will sponsor a Drawing Conference in one of the larger mid-western cities during the latter part of February at which contacts with industrial leaders on the one hand and with high school teachers on the other will be made. The general plan of the meeting will follow that of the mid-winter conference of last year.

Committees of the Division for 1940–41:

Executive Committee:

R. P. Hoelscher, Division Chmn.
C. V. Mann, Retiring Chairman.
W. H. Seegrist, Secretary.
F. H. Heacock, elected, 5 years.
A. L. Tobias, 4 yrs.
N. D. Thomas, 3 yrs.
H. C. Spencer, 2 yrs.
A. S. Levens, 1 yr.

Journal of Engineering Drawing:

F. W. Slantz, Chairman and Editor.
F. M. Porter, Advertising.
R. R. Worsencroft, Subscription.

Editor of T-Square Page: Boynton M. Green.

Graphic Talents and Visualization Tests: C. V. Mann, Chmn., H. C. Hesse, W. E. Street, J. L. Hill, W. R. Graney.

Drawing Competition: G. M. Phelps, Chairman, S. G. Hall, Fridtjof Paulsen, Jasper Gerardi, F. R. Finch, O. A. St. Clair.

Historical Research Committee: J. M. Russ (drawings), Chairman, F. M. Porter (books), F. W. Ming (instruments).

Committee on Applied Descriptive Geometry: A. S. Levens, Chmn., J. H. Porsch, C. H. Schumann, Jr., C. H. Springer.

Drawing Instruments: H. M. McCully, Chairman, H. S. Weber, F. T. Osborne, J. H. Butler.

Committee on Drafting Rooms, Lighting, and Equipment: Justus Rising, Chairman, J. N. Arnold, S. H. Pierce, J. O. Kraehenbuehl.

Committee on Drafting Standards: H. H. Jordan, Chairman, A. W. Leighton, H. W. Miller, K. G. Shiels, O. A. St. Clair.

NECROLOGY

EDWARD PECK CULVER was born at Mount Vernon, New York, November 4, 1892, the son of Stephen B. and Georgiana Peck Culver, and died August 21, 1940.

After preparation for college at the Hudson Falls High School, Professor Culver graduated from Union College with the degree of Bachelor of Engineering in 1915. After a year, 1916–1917, with the American Locomotive Company on problems of counter balance he entered the air service of the United States Army, being commissioned second lieutenant on the completion of the ground school course at the Massachusetts Institute of Technology. His first assignment was to Langley Field at Hampton, Virginia, and this was followed by one to Selfridge Field, Mount Clemens, Michigan. His special assignment to the Wright Martin factory was in connection with the elimination of certain service troubles with the Hispano-Suiza motors.

Professor Culver was appointed instructor in civil engineering at Princeton University in 1919 to give courses in mechanical engineering and drawing; in 1923 assistant professor of mechanical engineering; and in 1929 he was promoted to the grade of associate professor and took complete charge of the courses in laboratory, kinematics and graphic statics.

Professor Culver acted as a consultant for experimental work and design on hydraulic rams at the Rife Company, on centrifugal pumps for the Labawco Company, and on a special form of tester for brake linings for the Thermoid Company. Professor Culver was a member of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education and the Society of Automotive Engineers.

NEW MEMBERS

BAUER, JOHN V., Instructor in Civil Engineering, College of the City of New York, New York City. D. M. MacAlpine, Paul Hartman.

BAUMGARTEN, WILLIAM L., Assistant Professor of Architecture, North Carolina State College, Raleigh, N. C. B. R. Van Leer, J. M. Clarkson.

BEWLEY, L. V., Head, Dept. of Electrical Engineering, Lehigh University, Bethlehem, Pa. A. C. Callen, J. L. Beaver.

BINDER, RAYMOND C., Associate Professor of Mechanical Engineering and Fluid Mechanics, Purdue University, Lafayette, Ind. G. A. Young, W. J. Cope.

BOAST, WARREN B., Assistant Professor of Electrical Engineering, Iowa State College, Ames, Iowa. R. W. Ahlquist, F. H. McClain.

BRADLEY, FRANK R., Assistant Professor of Engineering Shop, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

BRADSHAW, WELDON L., Associate Professor of Architectural Engineering, Texas Technological College, Lubbock, Texas. O. V. Adams, H. L. Kipp.

BURKLAND, CARL E., Professor of English, University of Michigan, Ann Arbor, Mich. C. G. Brandes, E. L. Ericksen.

CHAMBERLAIN, JOS. J., Assistant Professor of Civil Engineering, University of Dayton, Dayton, Ohio. C. J. Belz, A. R. Weber.

CHURCH, A. H., Assistant Professor of Machine Design, New York University, New York City. Re-admission.

CLEMENT, WILLIAM B., Instructor in Mechanical Engineering, North Carolina State College, Raleigh, N. C. F. C. Bragg, W. E. Adams.

CLEMENTS, S. EUGENE, Instructor in Electrical Engineering, University of Kansas, Lawrence, Kansas. L. A. Zurcher, Richard Koopman.

CRAIN, RICHARD W., Instructor in Mechanical Engineering, University of Washington, Seattle, Wash. E. A. Loew, H. J. McIntyre.

CRANE, WILLIAM G., Assistant Professor of English, College of the City of New York, New York City. A. B. Newman, Frederick Kuhlen.

DIAMOND, AINSLEY H., Professor and Head, Dept. of Mathematics, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

DISQUE, FREDRICK C., Instructor in Chemistry and Mathematics, Pratt Institute, Brooklyn, N. Y. A. L. Cook, W. H. H. Cowles.

DREW, THOMAS B., Associate Professor of Chemical Engineering, Columbia University, New York City. T. H. Chilton, A. P. Colburn.

DURBIN, FRANK M., Associate Professor of Physics, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, E. C. Baker.

FAIRBANKS, HAROLD V., Instructor in Chemical Engineering, University of Louisville, Louisville, Ky. R. C. Ernst, G. C. Williams.

FAIRCLOTH, JAMES M., Associate Professor of Civil Engineering, University of Alabama, University, Ala. G. J. Davis, Oscar Dahlene.

FERRIS, DELACY F., Instructor in Mechanical Engineering, Rutgers University, New Brunswick, N. J. N. P. Bailey, W. C. Schulte.

FISHER, BENJAMIN A., Professor of Electrical Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

FLANDERS, ROGER L., Professor of Civil Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, E. E. Baker.

FLINSCH, HAROLD V., Assistant Professor of Civil Engineering, Bucknell University, Lewisburg, Pa. D. M. Griffith, G. A. Irland.

FOOS, CALDWELL B., Assistant Professor of Administrative Engineering, Syracuse University, Syracuse, N. Y. Louis Mitchell, H. W. Blackburn.

GRAVES, HAROLD E., Assistant Professor of Chemical Engineering, Worcester Polytechnic Institute, Worcester, Mass. J. M. Petrie, T. H. Morgan.

GRAY, HAMILTON, Assistant Professor of Civil Engineering, New York University, New York City. H. E. Wessman, W. C. Rose.

GLEASON, JAMES G., Instructor in Mechanical Engineering, University of Arkansas, Fayetteville, Ark. G. P. Stocker, R. G. Paddock.

GREFFE, C. DALE, Instructor in Engineering Drawing, University of Louisville, Louisville, Ky. R. C. Ernst, H. H. Fenwick.

GROSSER, CHRISTIAN E., Instructor in Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. C. E. Tucker, A. L. Townsend.

HALL, HOWARD P., Instructor in Engineering, Northwestern Technological Institute, Evanston, Ill. J. F. Calvert, G. A. Maney.

HAZEN, LESLIE E., Head, Dept. of Agricultural Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, E. C. Baker.

HILLYARD, LAWRENCE R., Instructor in General Engineering, Iowa State College, Ames, Iowa. J. C. Hempstead, H. J. Gilkey.

HOOPER, WM. T., Instructor in Civil Engineering, University of Pittsburgh, Pittsburgh, Pa. L. C. McCandliss, R. F. Edgar.

HUMMEL, JESSE G., Associate Professor of Mechanical Engineering, Iowa State College, Ames, Iowa. M. P. Cleghorn, R. E. Roudebush.

HUNTINGTON, HAROLD A., Professor and Head, Dept. Trade and Industrial Education, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

JORDAN, WILLIAM, Assistant Professor of Electrical Engineering, Newark College of Engineering, Newark, N. J. P. S. Schweizer, H. F. Ritterbusch.

KEITH, JESSE I., Professor and Head, Dept. of Food Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

KING, DAVID H., Instructor in General Engineering, Iowa State College, Ames, Iowa. F. C. Dana, J. C. Hempstead.

KING, RICHARD, Instructor in Civil Engineering, University of Connecticut, Storrs, Conn. Dana Young, C. O. Dohrenwend.

KNOLL, HORTON B., Assistant Professor of English, Purdue University, Lafayette, Ind. H. L. Solberg, H. L. Creek.

KRAYBILL, EDWARD K., Instructor in Electrical Engineering, Duke University, Durham, N. C. W. H. Hall, W. J. Seeley.

LUNDE, OTTO H., Professor and Head, Dept. of Aeronautical Engineering, University of Alabama, University, Ala. G. J. Davis, Oscar Dahlene.

MILLER, LYNN T., Instructor in Electrical Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

MUIR, ROY C., Vice President, General Electric Co., Schenectady, N. Y. M. M. Boring, A. C. Stevens.

NICKOLLS, CHARLES L., Professor of Chemical Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, E. C. Baker.

NOTHSTINE, LEO V., Instructor in Civil Engineering, Texas Technological College, Lubbock, Texas. H. L. Kipp, J. H. Murdough.

OSBORN, JOHN R., Instructor in Civil Engineering, A. & M. College of Texas, College Station, Texas. J. T. L. McNew, M. W. Furr.

OSBORNE, DONALD S., Instructor in Engineering Drawing, Wayne University, Detroit, Mich. R. H. Schoonover, R. T. Northrup.

PICKARD, WILLIS L., Instructor in Mathematics, North Texas Agricultural College, Arlington, Texas. F. M. Smith, E. J. Goodheart.

POWELL, ARNOLD F., Instructor in English, University of Alabama, University, Ala. G. J. Davis, Oscar Dahlene.

RECORD, FRANK A., Instructor in Electrical Engineering, Clarkson College of Technology, Potsdam, N. Y. H. A. Weiss, J. A. Ross.

REGER, AUDRA W., Instructor in Mechanical Engineering, Texas Technological College, Lubbock, Texas. H. L. Kipp, O. V. Adams.

RICE, WILLIAM H., Assistant Professor of Engineering Shops, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

SANFORD, CARL N., Assistant Professor of Aeronautical Engineering, North Carolina State College, Raleigh, N. C. F. C. Brown, H. E. Satterfield.

SARTAIN, CARL C., Instructor in Physics, University of Alabama, University, Ala. G. J. Davis, Oscar Dahlene.

SCARTH, VIRGIL, Associate Professor of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, R. G. Saxton.

SHERWOOD, ROBERT S., Instructor in Mechanical Engineering, Iowa State College, Ames, Iowa. M. P. Cleghorn, R. A. Higdon.

SKELLEY, CHARLES L., Associate Editor, College Dept., The Macmillan Company, 60 Fifth Avenue, New York City. A. S. Langsdorf, E. R. Hedrick.

SMITH, GEORGE E., Assistant Professor of Industrial Arts, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, E. C. Baker.

SMITH, JAMES H., Instructor in Electrical Engineering, University of Illinois, Urbana, Ill. J. O. Krathenbuehl, M. A. Faucett.

SMITH, OTTO M., Head, Chemical Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

SODERSTROM, E. D., Associate Professor of Engineering Shop, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

SPARKS, FRED W., Professor of Mathematics, Texas Technological College, Lubbock, Texas. H. L. Kipp, F. L. McRee.

STEELE, ARLO L., Instructor in Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, E. C. Baker.

SWIFT, ROY E., Instructor in Metallurgy, Louisiana State University, University, La. Clair V. Mann, H. H. Armsby.

THOMAN, WM. H., Associate Professor of Civil Engineering, University of Colorado, Boulder, Colo. C. L. Eckel, Warren Raeder.

THOROGOOD, BRACKETT K., Director, Franklin Union Technical Institute, Boston, Mass. Readmission.

VAIL, CHARLES R., Instructor in Electrical Engineering, Duke University, Durham, N. C. W. H. Hall, W. J. Seeley.

VENN, ROLLO E., Assistant Professor of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, A. Naeter.

VENNUM, ROBERT R., Instructor in Mechanical Engineering, Rutgers University, New Brunswick, N. J. N. P. Bailey, W. C. Schulte.

WALTON, IVAN H., Associate Professor of English, University of Michigan, Ann Arbor, Mich. C. G. Brandes, E. L. Ericksen.

WATT, DAVID M., Employment and Training Dept., Industrial Relations Division, Procter & Gamble Co., Ivorydale, Ohio. J. C. Whitwell, F. G. Atkinson.

WILSON, ERNEST D., Head, Dept. of Chemical Engineering and Chemistry, Worcester Polytechnic Institute, Worcester, Mass. T. H. Morgan, F. J. Adams.

WINFREY, ROBLEY, Research Associate Professor of Civil Engineering, Iowa State College, Ames, Iowa. J. C. Hempstead, H. J. Gilkey.

WOLMAN, ABEL, Professor of Sanitary Engineering, The Johns Hopkins University, Baltimore, Md. A. G. Christie, J. O. Geyer.

YOUNG, MILTON G., Instructor in Electrical Engineering, University of Delaware, Newark, Del. R. L. Spencer, T. D. Mylrea.

YOUNG, VINCENT W., Professor of Mechanical Engineering, Oklahoma A. & M. College, Stillwater, Okla. V. L. Maleev, E. C. Baker.

ZIMMERMAN, HAYDEN, Instructor in Mechanical Engineering, University of Alabama, University, Ala. Oscar Dahlene, G. J. Davis.

102 new members, 10–28–40

CORRECTION

On page 93, October JOURNAL, the **Nominating Committee** consists of all Past Presidents and those members of Council whose terms of office expire in 1942.

Division of Technical Institutes: John T. Faig, **Chairman**, Ohio Mechanics Institute, Cincinnati, Ohio; C. W. Banks, A. L. Cook, P. R. Kolbe.

COLLEGE NOTES

Polytechnic Institute of Brooklyn.—Bruce D. Greenshields, formerly professor of engineering science at Denison University, and for the past three years associate professor of civil engineering at the College of the City of New York, has been appointed adjunct professor of civil engineering.

University of Illinois.—Three members of the staff of the College of Engineering were retired on September 1: F. R. Watson, as Professor of Experimental Physics, Emeritus; W. F. Schulz, as Associate Professor of Physics, Emeritus; and E. C. Schmidt, as Professor of Railway Engineering, Emeritus. On account of ill health, Professor Schmidt was retired before reaching the statutory age limit. After his retirement, the Railway Engineering Department was discontinued and the work in the three divisions—railway mechanical engineering, railway electrical engineering, and railway civil engineering—was returned to the parent departments.

J. J. Doland, Professor of Civil Engineering, who was on sabbatical leave of absence last semester, resumed his work with the University this semester. During his leave, Professor Doland inspected civil engineering work in Panama and other countries of Central America and throughout the greater portion of the United States. J. O. Kraehenbuehl, Professor of Electrical Engineering, who was also on leave during last semester, resumed his work here at the beginning of this semester. During his absence, Professor Kraehenbuehl spent most of his time in the Nela Park plant of the General Electric Company, studying in the field of illuminating engineering.

W. H. Rayner, Assistant Professor of Civil Engineering, is on sabbatical leave this semester to study in the eastern and southern parts of the United States on the subject of aerial surveys. H. M. Mott-Smith, Associate Professor of Physics, is on sabbatical leave for the entire current year to study in Harvard University, Massachusetts Institute of Technology, and in various industrial plants on the subject of acoustics. J. H. Bartlett, Jr., Associate Professor of Theoretical Physics, is on leave also for the entire year for special study of Physics at Cornell University on a fellowship from the Rockefeller Foundation.

M. R. Riddell, who is Associate Professor of Aeronautical Engineering and Assistant to the Director of the Engineering Experiment Station, and who was taken ill last spring, has practically

recovered and is now carrying on his usual activities at the University. W. H. Severns, Professor of Mechanical Engineering, who also became ill during last semester, has not yet recovered to the point where he is able to meet his classes, although he is materially improved.

On September 1, H. L. Walker was made Acting Head of the Department of Mining and Metallurgical Engineering for the current year. During last year the work in the department was administered jointly by Professor Walker, who had charge of the division of metallurgy, and by Professor H. P. Nicholson, who had charge of the division of mining. Two promotions effective this year were: D. W. Kerst from Instructor in Physics to Assistant Professor of Physics, and A. E. Badger from Research Associate in Ceramic Engineering to Research Assistant Professor of Ceramic Engineering.

Lehigh University.—L. V. Bewley, whose appointment as professor of electrical engineering and head of the Department of Electrical Engineering was announced in the June issue, arrived on the campus September 1 to take up his new duties.

Additional appointments to the staff of the College of Engineering include Douglas E. Mode, instructor in electrical engineering. Mr. Mode received his Bachelor's and Master's degrees in electrical engineering from the University of Pennsylvania in 1935 and 1936 respectively. Since then he has been design engineer with the General Electric Company in Philadelphia and has taken advanced graduate work at the University of Pennsylvania. He is a member of Tau Beta Pi and Eta Kappa Nu.

Frank J. Fornoff, instructor in chemistry, graduated from the University of Illinois in 1936 and received the degrees of Master of Science and Doctor of Philosophy from Ohio State University in 1937 and 1939 respectively. Last year he was National Research Council Fellow in Chemistry at the University of California. He is a member of Phi Beta Kappa, Sigma Xi, Phi Kappa Phi, Phi Lambda Upsilon and Phi Eta Sigma.

James V. Eppes, instructor in mechanical engineering, graduated at the University of Virginia in 1928 and received his M.E. from Cornell in 1931. Since graduation from Cornell Mr. Eppes has been with the Texas Company. He is a member of Tau Beta Pi and Phi Kappa Phi.

Walton Forstall, Jr., instructor in mechanical engineering, graduated at Lehigh in 1931 with the degree of B.S. in M.E. Since graduation he has been with the Philadelphia Gas Works Company in various departments and has also been a member of the

technical staff in Physics at the Franklin Institute Museum. He is a member of Tau Beta Pi, Phi Beta Kappa and Pi Tau Sigma.

John H. Frye, who has been away for the last three years doing advanced graduate work and research in metallurgy in England and America, has returned with the rank of assistant professor of metallurgical engineering.

Ten additions to the staff of the **Missouri School of Mines and Metallurgy** were made during the past summer. James Ralph Coleman was appointed Instructor in Petroleum Engineering. He is a graduate in Petroleum Engineering from the University of Texas, and has had experience in the oil industry. He has also done graduate work at the University of Texas in 1939–40.

Charles Boyd Guest was appointed Assistant Professor of English. Professor Guest is a graduate in Education from the Delta State Teachers College at Cleveland, Mississippi, and received his M.S. degree in English from Alabama Polytechnic Institute in 1932.

Robert M. Mains was appointed Instructor in Mechanics, holding a B.S. in Civil Engineering from the University of Colorado, and a M.S. in Civil Engineering from the University of Illinois. He was for two years Research Graduate Assistant in the Engineering Experiment Station at the University of Illinois.

Preston E. Cloud was appointed Instructor in Geology. Dr. Cloud received his Ph.D. degree at Yale last spring.

The enrollment at the School of Mines and Metallurgy this year reached a high of 907 students, an increase of 7 per cent over the same period for last year.

Harris Hall, the new Civil Engineering Building, which has been under construction on the campus for the last two years, was completed during the summer months and is now completely occupied, housing the departments of Civil Engineering, Mechanics and Biology. In addition certain space in the building has been allotted to the Regional Office of the Topographic Branch of the U. S. Geological Survey stationed here under the direction of Captain C. L. Sadler.

The new Chemical Engineering Building, to house the Department of Chemical Engineering and Chemistry, is under construction on the campus and will be completed some time during the present year.

Oregon State College.—College enrollment, 4715, an increase of 3 per cent. School of Engineering enrollment 1077, an increase of 12 per cent.

Department of Mechanical Engineering: Enrollment (Soph., Jr., Sr.) 228.

Staff Changes: D. Kybal added to staff as instructor. M.S. degree from Cal. Inst. of Tech., consultant for Douglas Aircraft Corporation.

New Equipment: A 32 HP Diesel engine, a 6¼ inch polariscope, and a 200 Kv. X-ray machine are recent additions.

New Quarters: A new photoelastic laboratory, a new fuels and lubricants laboratory, and an aeronuatical laboratory equipped with a small wind tunnel are among the new facilities added to the department.

Department of Civil Engineering: Enrollment (Soph., Jr., Sr.) 137.

Staff Changes: G. J. Cavanagh has been appointed instructor to replace R. S. Ayre who has left for Stanford to do graduate work. Mr. Cavanagh is a graduate of Oregon State College.

Department of Electrical Engineering: Enrollment (Soph., Jr., Sr.) 130.

Staff Changes: W. Pritchett, graduate of Oregon State, replaces F. W. Dickson as graduate assistant. Dickson has accepted a position as engineer of a radio broadcast station.

Research: Professor E. C. Starr has completed certain phases of a project covering precipitation static noise interference with radio communication to aircraft. This work was reported at the Summer Convention of the A. I. E. E. Professor F. A. Everest has completed a test procedure for electric fence units, and has published an engineering experiment paper on the subject.

Chemical Engineering: Enrollment (Fr., Soph., Jr., Sr.) 150.

Research: With the advantages of new and complete quarters and facilities, this department is conducting several important research projects. Among these is a method for utilizing low-grade chromite, especially as it occurs in the beach sands of the Pacific Coast. This research is in two parts, the first part being concerned with the previously mentioned Schulein process for the preparation of soluble chromates from the chromite. The second part is concerned with concentration of the chromite fraction of the beach sands to percentages that minimize handling costs and make extraction economical. It is felt that this project is of some importance nationally in view of the fact that chromium is one of the strategic minerals listed by the government and for which domestic supplies are limited. The research is being financed by the Martin Dennis Company of New Jersey.

General Engineering (C.E., M.E., E.E. Freshmen): *Enrollment* 317; *Industrial Arts: Enrollment* 115.

Staff Changes: K. K. Edgar has been added to the staff to replace R. C. Rhynearson who has entered industrial activities. Edgar is a graduate of Civil Engineering at Ohio State University,

in 1925. He completed the Master's degree, with a major in Industrial Engineering (same school) in 1934. Since then, Edgar has been a member of the staff of Industrial Engineering at Ohio State, with the rank of Assistant and later Instructor. He joined our staff here as Assistant Professor, effective in the spring term of last year. Edgar's responsibilities are for the Industrial Administration program, which is our application of Industrial Engineering, suited particularly to Pacific Coast conditions.

Pennsylvania State College.—An all Engineering School Get Together, sponsored by the local A. S. M. E. and the Pennsylvania State College Branch of the S. P. E. E., was held Friday evening, October 4, 1940, in Room 219 Electrical Engineering Building, Professor F. C. Stewart presiding.

Dean Hammond gave an excellent talk on "The Evolution of Engineering Education." This was followed by the election of officers of the Penn State Branch S. P. E. E. of the year 1940–1941. The following were declared elected by acclamation:

Chairman—Professor A. L. Tobias
Vice-Chairman—Professor F. T. Mavis
Secretary—Professor A. H. Zerban

The meeting was concluded with a tour of the new Electrical Engineering Building and with refreshments served in the Lobby of the new building.

ALBERT P. POWELL, *Secretary*

P.S.

This is probably the last communication from me as Secretary of the local Branch since "I did not choose to run" after service as Secretary since first elected in 1926.

A. P. P.

The University of Texas.—Since the year 1928, twenty-five new classroom buildings, two large (men and women) gymnasiums, and a large combined library-administration-language building have been erected on the campus of the University of Texas to more adequately accommodate its present day enrollment of more than 11,000 students, 1740 in engineering. In continuing this program of expansion, the Board of Regents recently (September 1940) awarded contracts for the immediate erection of two more buildings to the physical plant of the College of Engineering, one to house the Petroleum Engineering Department, and the other for the Chemical Engineering Department. These buildings should be ready for occupancy by September 1941.

In general, the Petroleum Engineering building has been designed to provide for a large undergraduate enrollment as well as facilities for graduate and research work on a scale fitting the position of the University of Texas in the nation's largest oil-producing state. The first floor will consist of a large general laboratory for undergraduate classes, a large equipment display and process laboratory, other smaller laboratories, such as, core laboratory, drilling fluid laboratory, and flow laboratory, also auxiliary space for repair shop and storage. The second and third floors will be used for natural-gas engineering laboratory, design room, unit-process laboratory, research laboratories, graduate seminar rooms and necessary office space.

More than one-third of the entire space in the Chemical Engineering building will be given over to the "Unit Operations Laboratory," which extends across one entire end of the building on all three floors. Here are to be installed large and tall (up to 45 feet) pieces of equipment, such as: pumps and pipe lines, heat transfer devices, steam-jacketed kettles, evaporators, filter presses, autoclaves, mixers, absorber and stripping columns, fractionating towers, tray and rotary driers, water cooling towers, spray chambers, crushers, grinders, tube mills, air classifiers, sedimentation tanks, furnaces, and batch and continuous kilns. The first floor will also contain the senior testing-analysis laboratory, gas-analysis laboratory, research laboratory, machine shop and storage space. The second floor will have the junior fuel laboratory, laboratories for analytical work and research, a laboratory instruction room, a seminar room, main storeroom, and several offices. The third floor will house two unit laboratories, several research and analytical laboratories, two preparation rooms, a balance room, and several offices.

BOOK REVIEWS

Illumination Engineering. EUGENE W. SCHILLING, E.E., Ph.D., Montana State College. International Textbook Company. First Edition, 1940. Price: $2.75. 294 Pages.

The fifteen chapters of this book have been apportioned so as to serve the two-fold purpose of a beginner's text and a practising engineer's handbook. The first chapter is introductory; while chapters two to five, inclusive, deal with fundamentals and might serve as a basic laboratory guide for work in the following subjects:

Photometry
Flux and candlepower calculations
Brightness and surface sources of light
Incandescent light sources.

A laboratory curriculum outline is suggested in chapter fifteen for such work.

Chapters six to fourteen inclusive present a summary of current practise in illumination design and application. The author cooperates in the present wide-spread effort to standardize the practise by including many tables and charts which have been recognized by the Illuminating Engineering Society. Indoor and outdoor lighting design, application, equipment, and standards, as well as certain special interests like sports lighting, gaseous and fluorescent lamps, are among the many subjects touched upon in these chapters. Since space does not permit the author adequate coverage of his many topics, he includes copious references among modern literature.

In general, the book is non-mathematical; chapters three and four require a knowledge of simple integration for flux, candlepower, and light-source calculations, but only such as the most elementary calculas course would provide. An excellent feature of the book is the many illustrations of modern equipment and apparatus incident to the present-day practise of illuminating engineering.

D. B. CHURCHILL

Design of Electrical Apparatus. JOHN H. KUHLMANN. John Wiley & Sons, New York. 2nd ed., 1940, 506 pages. $5.00.

The first edition of this book proved very successful as a design text because it was based on many years of design experience of

the author's followed by a number of years of teaching experience. The present edition is an improvement of the first edition bringing the design methods for the four general classes of machines covered, D.C. machines, synchronous machines, induction motors, and transformers, up-to-date.

This text is intended for courses where complete designs on paper are undertaken by the student. With the limited amount of time allotted to most electrical design courses, careful supervision is required with the work carried out in definite stages, so that the student can be expected, unless extra time is allowed, to complete his design the first time that he carries it through. While very comprehensive sample designs are given in the text, there are no design problems. Due to the excellent arrangement of the text a set of suggested designs for each section could be arranged in the form of continued problems with each problem calling for only that portion of a given design covered by a chapter in the text. Working up an answer book for such a set of problems would be very difficult but could be done by selecting say five options for each design. A set of problems and answer book for use with this text would be a great aid to the instructor and would materially improve teaching procedure in electrical design courses.

The largest portion of the work of most engineering departments is design with standard parts. Much of this is a rather curtailed type of design which can be classified as purely commercial work consisting of handling the large percentage of orders and quotations which are similar to but cannot be filled from the standard lines listed in the catalog. Most engineering graduates starting in design departments do commercial work where standard parts are used down to the last possible detail. In this type of work, guarantees are often met by modifying as little as possible some previous design on which test data is available. For those electrical engineering students who will later do commercial work in design departments, for those who will be connected with sales work of manufacturing companies, and for those who will be connected with operating companies, a course in design fundamentals as given in this text can be of great value.

When a design has been carefully carried through following the method of this text, it can be expected that the predicted performance will be reasonably near the performance which would be obtained if the machine were constructed and tested. This text is therefore a book which will prove of value to the electrical designer in actual design work.

Principles of Direct-Current Machinery. A. S. LANGSDORF. McGraw-Hill Book Co., New York. 5th ed., 1940. $5.50.

This well-known text has received an extensive improvement in this edition. There are now five preliminary chapters on D.C. circuits, magnetism, electromagnetism, electrostatics, and systems of electrical units, covering 264 pages, which is sufficient for a semester course introductory to the study of D.C. machinery.

Starting with chapter VI, page 265, the entire remainder of the book through page 704 discusses the elementary constructional features and the operating characteristics of D.C. generators and motors. The treatment is the same as in previous editions but greater unity has been obtained by minor rearrangements and partial rewriting of some chapters. The mathematical analysis of commutation has been discarded, except in a limited section at the end of the chapter, for a definitely improved, non-mathematical treatment. The treatment of D.C. machinery as given in this text is now largely non-mathematical throughout, which has improved the uniformity and quality of the book.

Previous editions of this text have proven very satisfactory in class work and this edition should meet the needs of many junior electrical engineering courses in D.C. machinery even better than previous editions have.

A new set of problems is included at the end of the book. There are 142 problems for the first five chapters and 83 for the eight chapters on D.C. machinery.

Electric Circuits, by Electrical Engineering Staff of Massachusetts Institute of Technology. John Wiley & Sons, N. Y. 1st ed., 1940. $7.50.

Chapter I, the derivation and evaluation of circuit parameters, includes 120 pages and is largely a description of lumped circuit parameters including their determination from field theory and the practical forms they assume such as units of resistance, capacitance, self-inductance, and mutual-inductance. Starting with the line and surface integrals of field theory has advantages in instruction since the circuit parameters follow naturally from the configurations producing the fields or the current distribution. When he understands the derived nature of the parameters, it is easier for the student to visualize the application of laws of equilibrium to networks.

Nine chapters, pages 121 to 514, cover in a very complete manner the elementary steady-state and transient analysis of D.C. and single phase A.C. linear circuits with lumped parameters. The

problems include a wide selection of different types of circuits including network and bridge circuits within the practical range of analytical solution. The use of the Network Analyzer is discussed for the steady-state solution of networks of complexity beyond the practical range of solution by determinants.

In the two chapters, 95 pages, allotted to polyphase systems and elementary theory of symmetrical components, the emphasis is placed nearly 100 per cent on three-phase circuits giving an excellent introduction to the subject as applied in power generation and distribution. The selection of problems includes 22 on balanced circuits and 10 on unbalanced circuits.

The last two chapters, including 113 pages, cover electromechanically coupled systems and transients in nonlinear circuits. Both chapters are well supplied with problems, particularly of the type of frequent occurrence in communications.

The text considers lumped parameters only and does not include distributed parameters.

The book should be of particular value where a carefully coordinated laboratory course in circuits with lumped parameters were carried on simultaneously. The laboratory should be equipped with Bridges and instruments, representative circuit equipment, oscillograph facilities, and, if possible, a Network Analyzer so that problems studied in class could be set up and solved experimentally for their steady-state solutions.

To completely cover this text would require a five hour course for one year including an associated laboratory course. In view of the present tendency to organize electrical engineering curriculums following a definite sequence of major courses from the sophomore through the senior year, this text which is intended to fit into a sequence is definitely a contribution to the progress of engineering education. Unquestionably, because of its breadth and unity, it will point the way toward the reduction of the present large number of small major courses in many curriculums into a few carefully organized major courses which will definitely be to the benefit of the electrical engineering student.

BERTRAM K. HOVEY

Electric Circuit and Machine Experiments. FREDERICK W. HEHRE AND J. ARTHUR BALMFORD. New York: John Wiley & Sons, Inc. 17 Chapters, 279 pages. Price $2.00.

From the list of laboratory tests available for teaching electrical engineering subjects, the authors of this laboratory manual have selected a series of tests which are especially well suited for non-electrical students. The series includes a sufficient number of

tests for elementary work in electrical engineering and a generous supply of tests for the non-electrical juniors and seniors.

Many of the experiments are accompanied with suggested references, "hook-ups," calculation methods and questions. A minimum of supplementary instructions seems necessary for the suggested laboratory work.

This publication has more complete instructions than most mimeographed sheets; hence, it should help to give the student a better understanding of what is to be done and the results expected. It is divided into seventeen chapters covering the standard courses in electrical engineering including temperature tests, electron tubes and illumination.

Plenty of diagrams and illustrative material makes this laboratory manual particularly attractive to laboratory teachers of non-electrical students.

R. C. GORHAM

FIFTH EDITION OF "WHO'S WHO IN ENGINEERING"

Engineers throughout the country will soon receive material, questionnaires, and previously printed records bearing on the new (5th) edition of "Who's Who in Engineering." This work is being revised under the editorship of W. S. Downs, with qualifications established by a committee of the engineering profession, composed as follows: Andrey A. Potter, chairman, Purdue University; Col. L. B. Lent, vice-chairman, executive secretary, American Engineering Council; F. L. Bishop, secretary, Society for Promotion of Engineering Education; C. E. Davies, secretary, The American Society of Mechanical Engineers; H. H. Henline, secretary, American Institute of Electrical Engineers; T. Keith Legaré, secretary, National Council State Boards of Engineering Examiners; A. B. Parsons, secretary, American Institute of Mining and Metallurgical Engineers; George T. Seabury, secretary, American Society of Civil Engineers; Stephen L. Tyler, secretary, American Institute of Chemical Engineers; John A. C. Warner, secretary and general manager, Society of Automotive Engineers.

G-E Campus News

SUPER STREAMLINING

IN this modern age practically every means of transportation is streamlined—automobiles, airplanes, trains, and even baby carriages. The closest approach to perfect streamlining, however, is probably not found in any one of the foregoing but in a General Electric steam turbine, where nozzles must be designed to direct steam at the buckets at just the right angle.

G-E engineers have streamlined turbine nozzles to a point where they absorb less than two per cent of the velocity energy of steam traveling through them. Working with models, engineers about 20 years ago found they could feel low-pressure spots in an air stream blown through nozzle sections. Literally and figuratively they were "putting the finger" on streamlining deficiencies. Now, in a special laboratory, air is forced through model nozzles at a terrific speed (more than 700 miles an hour) while mechanical "fingers" feel for points of eddy or friction loss, and an automatic machine records the results.

These "streamline" tests, conducted by young student engineers "on Test" under the direction of experienced engineers, give records of inestimable value in the constant search for new ways to build more efficient turbines.

SIX VOICES

PEOPLE who have qualms about broadcasting probably would have passed right out if they had been in the shoes of George A. Mead, N. Y. State Commander of the American Legion, when he broadcasted recently from General Electric's television studios at Schenectady, N. Y.

For the first time in history a voice was carried over every practical means of voice communication. Mead's talk, in addition to going out on the ultra-short-wave band accompanying the picture on television, was simultaneously carried by WGY on long-wave radio, WGEO on short-wave, W2XOY on frequency modulation, and by light beam and ordinary telephone. In all, six distinct frequency bands carried his words to the four corners of the earth.

Directors of this unusual broadcast were John Sheehan, Union, '25, manager of G-E short-wave broadcasting, and J. G. T. Gilmour, Union, '27, program manager of G.E.'s television station, W2XB.

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